DOCUMENT RESUME

ED 454 822	IR 020 801
TITLE	ICCE/ICCAI 2000 Full & Short Papers (Evaluation of Learning and Systems).
PUB DATE	2000-11-00
NOTE	145p.; In: Learning Societies in the New Millennium: Creativity, Caring & Commitments. International Conference on Computers in Education/International Conference on Computer-Assisted Instruction (Taipei, Taiwan, November 21-24, 2000); see IR 020 792. Some figures contain very small and illegible type.
PUB TYPE	Collected Works - General (020) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	*Computer Uses in Education; *Educational Assessment; *Educational Technology; Elementary Secondary Education; Evaluation Criteria; *Evaluation Methods; Foreign Countries; Higher Education; Information Technology; Systems Development; World Wide Web
IDENTIFIERS	*System Evaluation; Technology Integration; Web Based Instruction

ABSTRACT

This document contains the full and short papers on evaluation of learning and systems from ICCE/ICCAI 2000 (International Conference on Computers in Education/International Conference on Computer-Assisted Instruction) covering the following topics: a new method for efficient study of Kanji using mnemonics and software; a study on the relation between touch-typing skills and thinking-typing; effects of situated learning on college students; modeling an educational domain; an assessment framework for information technology integrated instruction; the effectiveness of World Wide Web-based application for mailing list; design and use of a multimedia composition-making system for children; applicability of an educational system assisting teachers of novice programming to actual education; defining educational research and development--a content analysis of journal articles and implications for instructional technology; design and evaluation of constructivist Web-based instructional systems; design and implementation of cooperative monitoring agent using mobile agent; development and evaluation of a Web-based in-service training system for improving the information and communications technology leadership of school teachers; development of a LAN (Local Area Network)-based formative evaluation module as an instructional management system; development of a Web system to support computer exercises and its operation; EDASEQ (Exploratory Data Analysis for Sequential Data)--a log-file analysis program for assessing navigation processes; evaluating educational multimedia; evaluation of class organization in computer literacy education; evaluation of the Web-based learning system; developing successful collaborative projects between European initial teacher education students; evaluating children interacting, collaborating, and learning with computers; implementation of an internal execution simulator and its application to computer literacy education; criteria and evaluation of metadata/keywords in image retrieval; the difficulty of asynchronous learning materials based on time distribution; the usability aspects of a universal brokerage and delivery system for the Pan-European higher education; the suitability of the keyboarding or

Reproductions supplied by EDRS are the best that can be made
from the original document.

non-keyboarding Chinese input method for sixth-grade students; and Xtrain--a GUI (Graphical User Interface)-based tool for multimedia presentations, instruction, and research. (MES)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 454 822

ICCE/ICCAI 2000 Full & Short Papers (Evaluation of Learning and Systems)

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL HAS
BEEN GRANTED BY

G.H. Marks

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it

☐ Minor changes have been made to improve reproduction quality

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy

IR020801

BEST COPY AVAILABLE

ICCE/ICCAI 2000

Learning Societies in the New Millennium: Creativity, Caring & Commitments

HOT NEWS

Background
Committees
Call for Papers
Deadlines
Registration
Program
Paper Acceptance
Reviewers
Venue & Travel Info.
Contact Info.
Host & Sponsors
Related Websites
Discussion Board
Proceedings

HOME

Proceedings

Content

▶Full & Short Papers (Evaluation of Learning and Systems)

A new method for efficient study of kanji using mnemonics and software
A Study on the Relation between Touch-typing Skill and Thinking-typing
An experiment of situated learning on college students
An approach to modeling an educational domain
An Assessment Framework for Information Technology Integrated Instruction
An Effectiveness Study of Web-based Application for Mailing List Summary and Review
An Empirical Study of Design and Use of a Multimedia Composition-Making System for Children
Applicability of an Educational System Assisting Teachers of Novice Programming to Actual Education
✓ Defining Educational R&D: A Content Analysis of Journal Articles and Implications for Instructional Technology
✓ Design and Evaluation of Constructivist Web-based Instructional Systems
Design and Implementation of Cooperative Monitoring Agent using Mobile Agent
Development and evaluation of web-based in-service training system for improving the ICT leadership of schoolteachers
Development of a LAN-based Formative Evaluation Module as an Instructional Management System
Development of a Web System to Support Computer Exercises and its Operation
EDASEQ - A log-file analysis program for assessing navigation processes
Evaluating educational multimedia: a case study
Evaluation of class organization in the computer literacy education
Evaluation of the Web-Based Learning System
Everything in Moderation? Developing successful collaborative projects between European initial teacher education students.
Explorers or Persisters? Evaluating Children Interacting, Collaborating and Learning with Computers
Implementation of an Internal Execution Simulator and its Application to Computer Literacy Education
The Criteria and Evaluation of Metadata/Keywords in Image Retrieval
The research on difficulty of asynchronous learning materials based on time distribution
The usability aspects of an universal brockerage and delivery system for the Pan-European higher education
Which Chinese input method is more suitable for sixth-grade pupils?keyboarding or non-keyboarding
Xtrain: A GUI based tool for Multimedia Presentations, Instruction, and

BEST COPY AVAILABLE

- Xtrain: A GUI based tool for Multimedia Presentations, Instruction, and Research

▲ HOME

A new method for efficient study of *Kanji* using mnemonics and software

Chris Houser*, Shigeki Yokoi and Takami Yasuda****
**Kinjo Gakuin University, Omori 2-1723 Moriyama-ku Nagoya 463-8521 Japan,*
houser@kinjo-u.ac.jp
***Nagoya University, Furo-cho Chikusa-ku Nagoya 464-8601 Japan*

Japanese children spend hundreds of hours, over nine years, studying some 2000 written characters called *kanji*. Incredibly, most foreign adults attempt to study the *kanji* using the *same* method. But without these hundreds of hours, their efforts generally fail. In *Remembering the Kanji,* James Heisig presents a radical method for studying *kanji*. In only 200 hours, Heisig claims, adults can learn the *kanji*. A wonderful improvement! But few students follow his method; most complain that 200 hours is still too long. This paper introduces a refinement of Heisig's technique, a refinement combining modern memory theory with software, a refinement reducing the required time to 40 hours. The first author, a forgetful *kanji* neophyte, learned the *kanji* with this method, studying an hour a day, five days a week, for two months. His recall exceeds 95%, approximating native Japanese. This paper targets both teachers and students of Japanese as a foreign language, providing the knowledge and software required to rapidly learn the *kanji*, and inviting them to participate in a wider experiment using these new technologies.

Keywords: **CALL, Kanji, SuperMemo, Efficient study**

1 The *Kanji*

Perhaps the most difficult part of learning Japanese is memorizing its enormous character set: the 2000-odd *kanji*. These characters were imported from China into Japan. Because each character was imported several times over the centuries, while the Chinese and Japanese languages were evolving, each character now has multiple readings and meanings. As a result, the Japanese writing system is arguably the world's most complex.

Japanese children study these *kanji* for hundreds of hours over nine years of schooling. They start studying when six years old, before they have developed the ability to abstract, and hence can learn the characters only by *muscle memory:* They write the characters repeatedly, typically 20 times each. This method works, but imperfectly: Even after all this study, and the review that comes with daily use, adult Japanese forget some characters.

Most foreigners studying Japanese as a foreign language (JFL) try to learn the *kanji* using the same method: They write the characters repeatedly, perhaps while verbalizing the character's meanings and readings [7]. But since few adult JFL students have the hundreds of hours this method requires, most fail [4].

2 Heisig's method for studying the *kanji*

Heisig [4] offers an alternative study method.
Goal. Heisig's method allows adult JFL students to learn the *writing* and a *single meaning* of 2042 *kanji*. This is a narrow goal: Students concentrate on learning this writing and single meaning, and postpone learning other meanings, all readings, and the multiple character compounds.
Method. Since Heisig targets adults, he is able to use a sophisticated method, a method beyond the grasp of six year olds. He is able to use a *rational* method for learning *kanji*. Heisig prepared his method by

1. assigning each character a *keyword* (its single meaning),

2. splitting each character into a handful of *parts*,
3. ordering the characters so that parts precede their uses, and
4. inventing a mnemonic story to help recall each character's parts.

The keyword is usually the most common of the several Japanese meanings. The parts come from various sources: Some are simpler *kanji*; others are *primitives* – collections of commonly occurring strokes. Some of these primitives were identified centuries ago by Chinese and Japanese linguists (who call them "radicals"); other primitives were simply invented by Heisig. In all, Heisig uses a few hundred parts. The crux of his method:

Each character is learned, not as a mass of random strokes, but as a logical collection of parts.

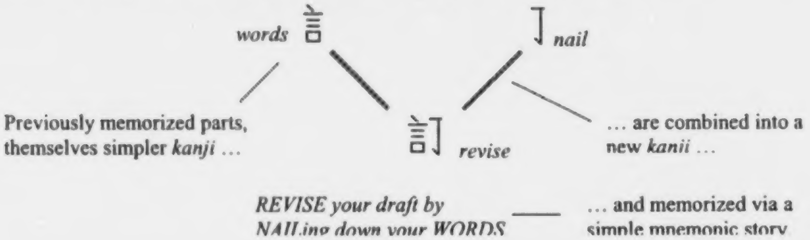
For example, consider the kanji with the keyword revise. This character has **nine meaningless strokes**, which prove quite a challenge to remember. But this same character has only **two parts** with the keywords *words* and *nail* – **meaningful** words which are much easier to remember. In effect, Heisig splits this character into these two parts, making a kind of equation: *revise* = *words* + *nail*. Most non-Japanese find this equation much simpler to recall than a meaningless jumble of nine strokes. When Heisig's students come to study *revise*, they have already learned the two parts – *word* and *nail* – since Heisig has sorted the *kanji* so that these parts precede their use in *revise*. By combining two previously learned parts, students easily remember this new character. But Heisig makes remembering even easier by providing a **mnemonic story**:

REVISE your draft by NAILing down your WORDS.

The image of "nailing down one's words" is so strong and logical that after students have read this mnemonic **once**, they will likely remember it for life.

This contrasts with Japanese students, who practice **writing** the character **repeatedly**, and may later forget it.

Heisig's main contribution is to **raise the level of abstraction** from strokes to parts. Rather than struggling to remember a large, sprawling jumble of meaningless jots and dashes, students effortlessly remember a simple story, calling to mind the few parts that compose a *kanji*:


words 言
丁 nail
Previously memorized parts, themselves simpler kanji …
訂 revise
… are combined into a new kanji …
REVISE your draft by NAILing down your WORDS
… and memorized via a simple mnemonic story

Study. Heisig has done most of the work: He has assigned the keywords, identified the parts, invented the primitives, and sorted the *kanji*. Students need only read the keyword and story a few times to memorize each *kanji*. Heisig predicts study will require 200 hours – far less than Japanese children spend on rote repetition.

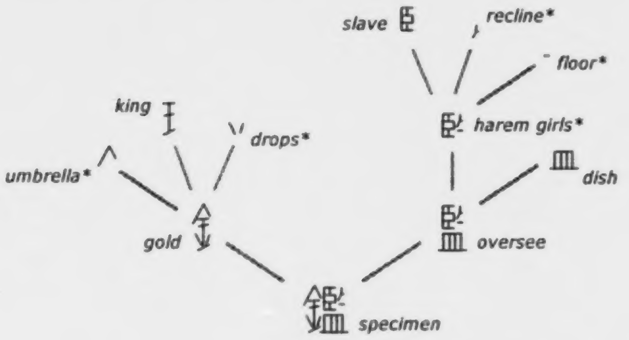
Analysis. Why is Heisig's method so effective? Here are three explanations.
Simplicity. The stories are simpler than the *kanji*, simpler because they have fewer components. Each *kanji* consists of between 1 and 23 strokes; 75% of the *kanji* have more than seven strokes. But all have fewer than seven parts. Now human short-term memory can hold only about seven items [6]. Objects with more than seven known components cannot fit in short-term memory, and so cannot be remembered, or even recognized. This predicts that students learning strokes will remember 25% of the *kanji*, but students learning parts will remember 100%.

Abstraction. Practicing strokes engages only muscle memory: Most of the student's brain remains dormant. Heisig's stories engage the higher faculties of language, actions, settings, events, humor, and metaphor. Such meaningful symbolic processing engages more of the brain, and hence is more easily recalled, than mere orthographic syntax [8]. Humans recall abstract meanings and stories long after they forget specific examples and images [5].

Relations. When learned by rote, each *kanji*, indeed each stroke, must be learned anew: Nothing is connected to anything else. When learned by parts, each *kanji* is connected to previously learned *kanji*.

Heisig's method is rich in connections. When students learn a character, they are also reviewing its parts. In turn, most parts appear repeatedly, and hence are memorized easily.

As an illustration, consider the daunting 23 strokes of *specimen*. Stroke-by-stroke memorization is all but impossible. But *specimen* comprises only two parts: *gold* and *oversee*. It is easily recalled with a story such as *GOLD diggers OVERSEE their mineral SPECIMENS. Specimen* is studied after *gold* and *oversee* have been learned, from their own parts, with their own stories. So each step of study is small and simple, but the steps build on each other – primitives are woven into *kanji*, which are in turn used to build further *kanji* – until a vast web of rich connections is built up in the student's mind.



Parts are either simpler *kanji*, or *primitives* (marked with *)

Problem: Still too difficult! Heisig's method is a great improvement over the Japanese method, but it is not perfect. For Heisig provides stories for only the first 500 of his *kanji*, and asks readers to invent their own stories for the remaining 1542. Faced with this burden, many of Heisig's students stop studying after 500 characters. And those who do continue need unusual discipline, need to painstakingly construct and review flash cards, need a scheduling system to study, review, and test.

3 Kanji Can

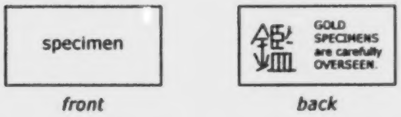
Kanji Can [3, 1] is a database with a *complete* set of 2042 mnemonic stories. The stories are excellent, surpassing even Heisig's first 500:

- Kanji Can's stories are shorter, and so easier to recall.
- Kanji Can's stories mention the parts in the order they are written.
  (Compare with Heisig's story for *revise* above, which reverses them.)

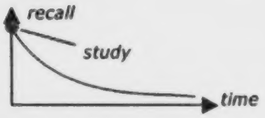
Kanji Can embraces Heisig's method, but extends his materials, and thus solves the problems mentioned above.

4 Flash Cards

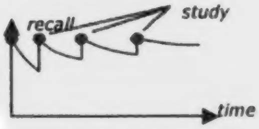
The chief tool of most memorizers is the humble flash card. Flash cards are small paper cards with a *stimulus* written on the front side, and a *response* on the back. When studying foreign language vocabulary, the stimulus is typically a word in one's native language, and the response is the word in the foreign vocabulary. When studying *kanji* using Heisig's method, the stimulus is the keyword, and the response is the *kanji* itself.


specimen
GOLD SPECIMENS are carefully OVERSEEN.
front
back

Students read the stimulus and try to produce the response. They then check their response against the desired response on the back of the card. Cards that were correctly recalled are removed from the deck; cards not recalled are shuffled to the back of the deck, to be reviewed again. Used this way, flash cards combine self-testing with review. The cards catch mistakes and save them, allowing review until the student knows them all. Flash cards



Memory fades after



Repeated study slows

are essential when following Heisig's method: Studying the stories is so easy that students will doubt they are really learning anything until they have been tested!

Problem: Inefficiency. Using flash cards takes a lot of time. Each card must be hand made. Then each card must be tested repeatedly, for only with repetition comes dependable memorization. Memory fades over time, but by reviewing partially forgotten material students extend their memories.

But how frequently should students review? Buzan [2] recommends review after ten minutes, a day, a week, a month, and then four months. But are these the best intervals for review? Testing too frequently wastes time reviewing material already well known. Testing too infrequently wastes time relearning forgotten material. The goal of flash cards is to "catch" learners just before they fall – to remind them just as they are about to forget. But the point of forgetting – and hence the optimal review interval – differs for each student, and even for each *kanji*: Some are easier to remember than others. How can we optimize study?

5 Super Memo

Super Memo is a general flash card program [9]. Like paper flash cards, these electronic cards can be used to review anything, including the *kanji*. Unlike paper cards, these electronic cards are neat and easily editable, but require a PC. Super Memo is better than paper flash cards because it contains a mathematical model of human forgetting: It can predict when a student will forget a *kanji*, and hence compute the best testing time. When testing with Super Memo, students tell the program how well they remember each *kanji*; the program uses this information to tune its model to each student, and to each *kanji*. The result closely approximates perfectly timed intervals, and hence maximum efficiency in studying.

Independent of the nature and amount of material they study, students using Super Memo all learn approximately 200 items/minute/year. This means that by studying one minute, every day, for a year, one can learn 200 items; or, by studying 10 minutes a day, 2000 items. This is much faster than many other study methods; in particular, Super Memo implies results in 1/5 of Heisig's time.

Super Memo's computerized scheduling provides more than optimal reviews. It also provides an incentive to study every day. A student using Super Memo runs the program every day and finds a list of items to review. If the student skips a day, the next day she will be confronted with twice as many items! This threat helps provide the discipline necessary in learning a large body of material, such as the *kanji*. (Unfortunately, this also means that if the student skips a week, she will be confronted with a mountain of review, and will likely quit altogether. Super Memo is not for the timid.)

6 New technology allows learning the *kanji* in only 40 hours!

This paper proposes a new method for learning the *kanji*, a method combining Heisig's novel ideas, Kanji Can's stories, and Super Memo's reviewing. Heisig provides the tractable goal and the idea of using mnemonic stories to recall the writing of *kanji* in terms of their parts. Kanji Can provides a complete set of these mnemonic stories. And Super Memo provides strict scheduling and efficient reviewing and testing. The combination of these three educational technologies provides a most efficient *kanji* learning method: the complete set of 2042 *kanji* can be learned in only 40 hours!

These 40 hours might be scheduled as 10 minutes a day, every day for a year, or an hour a day, five days a week, for two months. Memory manuals claim that an hour's study a day is optimal: Shorter study sessions waste time in frequent physical and mental preparation, longer study sessions induce fatigue, and both degrade efficiency [2, 5].

The first author learned the *kanji* in 40 hours by following this method.

Heisig has greatly accelerated *kanji* learning for adult JFL students. Kanji Can's complete set of stories enables students to concentrate on studying the *kanji*. Super Memo provides a well-documented speedup for any rote memorization. Combining these three technologies, we can learn the *kanji* in only 40 hours.

References

[1] Breen, J., *KanjiDic*, ftp://ftp.cc.monash.edu.au/pub/nihongo/00INDEX.html (2000).

[2] Buzan, T., *Make the most of your mind*, Pan, London (1977).

[3] Donaghue, M., *Kanji Can*, http://www.kanjisoft.com (2000).

[4] Heisig, J., *Remembering the Kanji I*, Japan Publications Trading Co., Tokyo (1977).

[5] Maddox, H., *How to study*, Ballantine, New York (1963).

[6] Miller, G., "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information", *The Psychological Review*, vol. 63, pp. 81-97, http://www.well.com/user/smalin/miller.html (1956).

[7] Sakade, F., Emori, K., Friedrich, R., Ohashi, S., *A guide to reading & writing Japanese*, Charles E Tuttle, Rutland, Vermont (1959).

[8] Schmidt, U. & Geyser, A., "How to study 2000 kanji in a few weeks", *Proceedings of ICCE 99*, pp. 595-598 (1999).

[9] Wozniak, P., *Super Memo*, http://www.supermemo.com (2000).

A Study on the Relation between Touch-typing Skill and Thinking-typing

Yuji YOHINAGA* and Hiroaki KAWABATA**
The Graduate School of System Engineering, Okayama Prefectural University
111 Kuboki, Soja, Okayama, 719-1197, Japan
*E-mail: *yoshinaga@mx3.tiki.ne.jp **kawabata@cse.oka-pu.ac.jp*

Word processor is more and more widely used as a tool of externalization and reflection of thinking in recent years in Japan. In that case, it will be necessary to type smoothly words or sentences appearing in the head (hereinafter referred to as "thinking-typing"). The experiments were made to study the relation between touch-typing skill and thinking-typing. The examinees were 46 non-computer majors of the university. The students were asked to type words or sentences appearing in their heads on 3 subjects. The touch-typing skill of the students was measured by touch-typing exercise software. The results suggested that a touch-typing speed of 2 strokes/second is necessary, at least, to type smoothly words or sentences appearing in the head. What's more, the results of the experiments suggested that learning of touch-typing skill is very effective on the increase of thinking-typing speed of the subject that is easy to be thought out.

Key words: **Thinking-typing, Touch-typing, Externalization, Self-evaluation, Analysis of variance**

1 Introduction

The methods for human beings to externalize their thinking are language expression, diagram expression, letter expression and so on [1]. Among these expressions, letters are widely expressed by word processors in recent years in Japan. The method of word processor's usage has been changed by the popularization of them. In other words, the method that uses a word processor to transcribe a manuscript written by handwriting, has been changed to the method that uses a word processor in the process of externalization and reflection of thinking. With the latter method, it is necessary to type smoothly words or sentences appearing in the head (hereinafter referred to as "thinking-typing"). Thinking-typing needs a certain level of typing skill. Although a number of studies have been made on typing [2] [3], there are few studies on thinking-typing.

In the lesson of computer exercise at the university, the first author is raising the level of students' typing skill through touch-typing education and, at the same time, is raising the ability of the students' utilizing a word processor as a tool of externalization and reflection of thinking [4]. In the lesson, the experiments of thinking-typing by touch-typing were made to study the relation between touch-typing skill and thinking-typing. Touch-typing speed and self-evaluation of thinking-typing were adopted as the scale of thinking-typing level. The first experiment (Experiment 1) was made in July, 1999, and the second experiment (Experiment 2) was made in February, 2000. In this paper, results regarding Experiment 2, and comparison between Experiment 1 and Experiment 2 are reported, because results regarding Experiment 1 had been reported already [5] [6].

2 Method

The experiments of thinking-typing by touch-typing were made in the lesson of the computer exercise for the first-year students at the university. In this study, the data of 46 students, whose data of Experiment 1 and Experiment 2 were complete, were analyzed. In the experiments, the students typed the following subjects by touch-typing.

One-way analysis of variance was used to test for significant differences in thinking-typing speed among the 4 touch-typing levels. As a result, touch-typing skill had main effect in the 3 subjects(*Shiritori*: $F=12.46$, $df=3$, $p<.01$ Imagination: $F=11.31$, $df=3$, $p<.01$ Impression: $F=23.55$, $df=3$, $p<.01$). What's more, Tukey's multiple comparisons test was applied to identify whether there are significant differences in thinking-typing speed among the 4 touch-typing levels or not. The results are shown in **Table 2**. Homogeneity subgroup is a group of similar levels whose difference is not significant. In the 3 subjects, there were significant differences of thinking-typing speed between the level under 2 minutes and the level over 2 minutes. These results show that reaching touch-typing level under 2 minutes in Experiment 2 was one of the conditions to type smoothly words or sentences appearing in the head.

Tabel 2. Tukey's multiple comparison of thinking-typing speed

	Touch-typing skill	Number of persons	Homogeneity subgroup		
			Gr1	Gr2	Gr3
Shiritori	Level under 1 minute	6	1.13		
	Level of 1 minute	23		0.84	
	Level of 2 minutes	12		0.59	0.59
	Level of 3 minutes	5			0.51
Imagination	Level under 1 minute	6	0.65		
	Level of 1 minute	23	0.52	0.52	
	Level of 2 minutes	12		0.35	0.35
	Level of 3 minutes	5			0.28
Impression	Level under 1 minute	6	1.08		
	Level of 1 minute	23		0.72	
	Level of 2 minutes	12			0.47
	Level of 3 minutes	5			0.42

p .05 *f*

3.2 Relation between Touch-typing Skill and Self-evaluation of Thinking-typing

Self-evaluation of Experiment 2 was divided into positive self-evaluation and negative self-evaluation to study the relation between self-evaluation and touch-typing skill. Positive self-evaluation is "very good", "good" and "a little good". Negative self-evaluation is "a little bad", "bad" and "very bad". As for self-evaluation point, positive self-evaluation is 1 point, and negative self-evaluation is 0 point. The mean of self-evaluation point of each touch-typing level is shown in **Table 3**.

Table 3. Touch-typing skill and self-evaluation

Touch-typing skill	Number of persons	Self-evaluation point					
		Shiritori		Imagination		Impression	
		Thinking	Typing	Thinking	Typing	Thinking	Typing
Level under 1 minute	6	0.50	1.00	0.17	1.00	1.00	1.00
Level of 1 minute	23	0.61	0.96	0.52	0.96	0.74	0.96
Level of 2 minutes	12	0.67	0.75	0.42	0.83	0.83	0.75
Level of 3 minutes	5	0.40	0.60	0.40	0.40	0.80	0.40
All the examinees	46	0.59	0.87	0.43	0.87	0.80	0.85

One-way analysis of variance was used to test for significant differences in self-evaluation point among the 4 touch-typing levels. As a result, touch-typing skill had main effect in the typing evaluation of imagination and in the typing evaluation of impression (typing evaluation of imagination: $F=5.11$, $df=3$, $p<.01$ typing evaluation of impression: $F=4.86$, $df=3$, $p<.01$). What's more, Tukey's multiple comparisons test was applied to identify whether there are significant differences about the typing evaluation of imagination and the typing evaluation of impression among the 4 touch-typing levels or not. The results are shown in **Table 4**. Typing evaluation of Level of 3 minutes in imagination was significantly lower than other touch-typing levels, and typing evaluation of Level of 3 minutes in impression was significantly lower than Level under 1 minute and Level of 1 minute. These results show that the students of Level of 3 minutes could not type smoothly imagination or impression, comparing with the students of other touch-typing levels.

【Subjects of Experiment 1】

Subject 1: Type words that you think with *shiritori* (a Japanese word chain game*)*. Type them by *hiragana* (Japanese alphabet). The time limit is 3 minutes.

Subject 2: Type words that you image with "university". Type them by *hiragana-kanji* (Japanese alphabet – Chinese characters) translation. The time limit is 5 minutes.

Subject 3: Type sentences of your self-introduction. Type them by *hiragana-kanji* translation. The time limit is 10 minutes.

【Subjects of Experiment 2】

Subject 1: Same as Subject 1 of Experiment 1.

Subject 2: Type words that you image with "student life". Type them by *hiragana-kanji* translation. The time limit is 5 minutes.

Subject 3: Type sentences of your impression about the lesson of the computer exercise. Type them by *hiragana-kanji* translation. The time limit is 10 minutes.

After the experiment, the students evaluated themselves on the 3 subjects. In Experiment 2, the students evaluated themselves on whether they could think out words and sentences or not (thinking evaluation), whether they could type words and sentences by touch-typing or not (typing evaluation). The evaluation standard was divided into 6 levels: "very good", "good", "a little good", "a little bad", "bad" and "very bad".

The touch-typing skill of the students was measured in the lessons before and after the lesson of the experiments. The measurement content is testing typing time of entering Japanese sentences of *hiragana* (about 240 strokes) that were displayed in a monitor at random, by *romaji* (Japanese Roman characters) input and touch-typing.

3 Results and Discussion

3.1 Relation between Touch-typing Skill and Thinking-typing Speed

Touch-typing skill in Experiment 2 was divided into 4 levels: under 1 minute (Level under 1 minute), between 1 minute and 2 minutes (Level of 1 minute), between 2 minutes and 3 minutes (Level of 2 minutes), between 3 minutes and 4 minutes (Level of 3 minutes). The mean and the standard deviation of thinking-typing speed in each touch-typing level are shown in **Table 1**. Thinking-typing speed in each subject was calculated by the next equation.

$$s = \frac{L}{T}$$

s : Thinking-typing speed in each subject

L : Typing linage in each subject*

T : Time limit in each subject (minute)

＊Number of letters per line, after *hiragana-kanji* translation, is 40.

Table 1. Touch-typing skill and thinking-typing speed

Touch-typing skill	Number of persons	Thinking-typing speed (linage/minute)					
		Shiritori		Imagination		Impression	
		M	*SD*	*M*	*SD*	*M*	*SD*
Level under 1 minute	6	1.13	0.25	0.65	0.16	1.07	0.14
Level of 1 minute	23	0.84	0.23	0.52	0.14	0.72	0.19
Level of 2 minutes	12	0.59	0.11	0.35	0.06	0.47	0.11
Level of 3 minutes	5	0.51	0.13	0.28	0.09	0.42	0.10
All the examinees	46	0.77	0.27	0.47	0.17	0.67	0.25

Table 4. Tukey's multiple comparison of self-evaluation

	Touch-typing skill	Number of persons	Homogeneity subgroup	
			Gr1	Gr2
Typing evaluation of imagination	Level under 1 minute	6	1.00	
	Level of 1 minute	23	0.96	
	Level of 2 minutes	12	0.83	
	Level of 3 minutes	5		0.40
Typing evaluation of impression	Level under 1 minute	6	1.00	
	Level of 1 minute	23	0.96	
	Level of 2 minutes	12	0.75	0.75
	Level of 3 minutes	5		0.40

p .05 f

3.3 Relation between Learning of Touch-typing Skill and Change of Thinking-typing Speed

The mean of learning ratio of touch-typing skill and the mean of change ratio of thinking-typing speed in each touch-typing level of Experiment 2 are shown in **Table 5**. Learning ratio and change ratio were calculated by the next equation.

$$\alpha = \frac{T1}{T2} \qquad \beta ? \frac{s1}{s2}$$

α . Learning ratio of touch-typing skill
$T1$: Touch-typing time of Experiment 1 (minute)
$T2$: Touch-typing time of Experiment 2 (minute)
β : Change ratio of thinking-typing speed
$s1$: Thinking-typing speed of Experiment 1 (linage/minute)
$s2$: Thinking-typing speed of Experiment 2 (linage/minute)

Two-way analysis of variance was used to test for significant differences in the 4 touch-typing levels and the 3 subjects about change ratio of thinking-typing speed in Table 5. As a result, main effect of the 3 subjects was significant($F=4.14$, $df=2$, $p<.05$). Main effect of the 4 touch-typing levels and interaction were not significant. What's more, Tukey's multiple comparisons test was applied to identify whether there are significant differences in change ratio of thinking-typing speed among the 3 subjects or not. As a result, there were significant differences of change ratio of thinking-typing speed between Subject 3 and other subjects. Next, correlation between learning ratio of touch-typing skill and charge ratio of thinking-typing speed is shown in Table 6. A moderate significant positive correlation was observed between learning ratio of touch-typing skill and change ratio of thinking-typing speed in Subject 3. So it can be said that learning of touch-typing skill is very effective on the increase of thinking-typing speed of Subject 3. What is the qualitative difference between Subject 3 and other subjects? It is the easiness of thinking. Thinking evaluation point in Table 3 expresses the easiness of thinking in each subject. Thinking evaluation point of impression (Subject 3) is higher than other subjects. So it is considered that words of impression (Subject 3) was easier to be thought out than other subjects. Therefore, it can be concluded that learning of touch-typing skill is very effective on the increase of thinking-typing speed of the subject that is easy to be thought out.

Table 5. Learning ratio of touch-typing skill and change ratio of thinking-typing speed

Touch-typing skill	Number of persons	Learning ratio of touch-typing	Change ratio of thinking-typing speed		
			Subject	Subject 2	Subject 3
Level under 1 minute	6	1.69	1.35	1.61	2.03
Level of 1 minute	23	1.58	1.24	1.47	1.93
Level of 2 minutes	12	1.57	1.18	1.57	1.61
Level of 3 minutes	5	1.50	1.89	1.47	1.80
All the examinees	46	1.58	1.31	1.51	1.84

Table 6. Correlation between learning ratio of touch-typing skill and change ratio of thinking-typing speed

	Change ratio of thinking-typing speed		
	Subject	Subject 2	Subject 3
Learning ratio of touch-typing	0.245	0.089	0.565**

**p .01 *f*

4 Conclusion

From what has been discussed about the relation between touch-typing skill and thinking-typing speed, and relation between touch-typing skill and self-evaluation of thinking-typing, it can be concluded that a touch-typing level under 2 minutes is necessary, at least, to type smoothly words or sentences appearing in the head. The speed of 240 strokes in 2 minutes equals 2 strokes/second. 2 strokes are needed to input a *hiragana*. So the speed of 120 *hiragana* in 2 minutes equals 1 *hiragana*/second. The aim of touch-typing education for thinking-typing should be set at 2 strokes/second (1 *hiragana*/second). What's more, from what has been discussed about the relation between learning of touch-typing skill and change of thinking-typing speed, it can be concluded that learning of touch-typing skill is very effective on the increase of thinking-typing speed of the subject that is easy to be thought out.

References

[1] Y. Saeki, "New Computer and Education", Iwanami Sinsyo, pp.104-105 (1997).

[2] T. Ohno, "The Effect of the Typing Skill for the Typing Process", Research Report of Information Processing Society of Japan(Human Interface), 63-6, pp.31-36 (1995).

[3] C. Kogo, "Use of electronic mail in assignments, term paper and final examination in college courses, and relationships between grades of them and typing skill", Research Report of Japan Society for Educational Technology Conferences, 96-4, pp.1-4 (1996).

[4] Y. Yoshinaga and H. Kawabata, "Touch-typing education in considering of self-evaluation", Proceedings of the 2000 IEICE General Conference(Information and System 1), p219(2000).

[5]Y. Yoshinaga and H. Kawabata, "A Experiment Report about Thinking-Typing by Touch-Typing", Proceedings of the Federation of Cyugoku Branch Electronics and Information 1999, pp.366-367(1999).

[6]Y. Yoshinaga and H. Kawabata, "A Study on the Effect of Touch-Typing Skill for Thinking-Typing", Advanced Research in Computers and Communications in Education(2), pp.833-834(1999).

An experiment of situated learning on college students

Fonchu Kuo*, Hin-chung Wong, Gin-Fon N. Ju***, P.M. Chen*, T.W. Lin*,**
Shu-Hui Liu and Hsiao-Chiao Hung****
**Department of Computer Science, Soochow University, Taipei, Taiwan, R.O.C.,*
P. O. Box 14-135, Taipei, Taiwan
E-mail: kfc@cis.scu.edu.tw
***Department of Microbiology, Soochow University, Taipei, Taiwan, R.O.C.*
No. 70, Lin-shi Road, Shi-lin Area, Taipei, Taiwan
wonghc@mail.scu.edu.tw
****Department of Psychology, Soochow University, Taipei, Taiwan, R.O.C.,*
No. 70,Lin-shi Road, Shi-lin Area, Taipei, Taiwan
gju@cis.scu.edu.tw

Several experiments of situated instruction have been done in elementary school. We conduct the inaugural experiment on college students. A group of 44 students who are taking food microbiology course involved in this experiment. We designed a science fiction named "Save the Taiwan", which is a story regarding a Microbiology technician handles a disease crisis. A student can learn how to deal with the crisis and solve the problem of an infectious disease when he uses this CAI software. The evaluation practice consists of four dimensions, subject domain demands, instructional demand, user interface demand, and pragmatic demands. The result of evaluation shows notable effect on college students.

Keywords: **situated learning, evaluation of CAI, Microbiology**

1 Introduction

The advantage of traditional instruction is that the knowledge that students learned can be "stiff knowledge". The stiff knowledge can not be smoothly applied to solve the actual problem in a real environment (Brown, 1989). Situated cognition bases on the theory that the learning should be constructed at real situation. Only when the learner derive the knowledge from the real situation then he realizes the real meaning of the learned knowledge and cherish the value of knowledge and take it as the tool for solving the problem. (Cognition and Technology Group at Vanderbilt, 1990)

There was experiment on elementary school student (Tsu, 1997). The experiment was focus on learning simple mathematics calculating. We conduct the experiment on college student, trying to find out if situated learning can be succeed on the domain of higher education. The students of Department of Microbiology have to take laboratory classes during the period of 4 years college. They always have the problem of how and where to apply what they have learned in the class. The instructive goals of laboratory class are diverse. Lazarowitz & Tamir (1992) believe that learning is a process of construction. Despite of learning the laboratory skill, oral discussion between instructor and students should be part of the learning process. In addition, a more inexpensive and more efficient instruction method, such as computer aided instruction or simulations, should be adapted in the class. Anchored situated instruction adapts computer technology to implement situated cognition theory. (Cognition and Technology Group at Vanderbilt,1990) In our software, we develop a pseudo but can be real situation, embedded the learning materials in the circumstances. Through the interaction between user and CAI software, learner can then practice the process of collecting and filtering information as well as the methods to solve the problem.

2 Design features of our approach

The script was written and designed by a professor of Department of Microbiology. We adopt several principles in our design.

1. Provide vivid circumstance. Multimedia allows us to design a vivid environment, so that the situation can avoid over-simplified and lack of context. (Yang, 1995). Multimedia also provides plentiful visual symbols, e.g. video images, graphic charts, sound as well as text to make the play more fun and close to real environment.

2. To hide useful information in the story, a learner may have trouble to transfer what he has learned to different situation if he was teaching in a simplified or provided obvious cue environment. Whereas, a learner can learn to justify what information can be useful and what information is not useful for solving the problem in a simulated situation.

3. To randomize the plot of the story, the learner can memorialize the plot if he has experienced in using this CAI software. This can then cause the learning process in vain. We use Random function in our design; one of the bacteria was picked randomly and then, in turn, develop different story.

4. To have productive result, there may be only one answer or solution in a traditional instruction. However, in a real environment, there may be more than one solution to solve the problem. They may be pros and cons from one to one, but they may all workable. We do not provide firm answer to user instead, we provide an open-ended environment for user to construct his own path and solution.

3 The story

3.1 Outline of the story

There is a food mediated infectious disease occurs in a small town that locates at the seashore of Taiwan island. Within a few days, this infectious disease has spread to nearby counties and caused many cases of death. Tai-shang (see photo 1), the leading actor, a technician of the local public health administration office, is responsible for finding out the etiologic agent of the disease. In the story, Tai-shang is facing many challenges like the ones in real life. His girl friend, professor and colleagues are all in the plot and interactive with him. After the accident happened, he had faced the pressure from his superior, public media, even from a local councilor. He must acts like a detective who searches the cue and a scientist who seeks for the truth of problem. Finally, with the encouragement of his college instructor, Ta-shang successfully finishes his task.

Photo 1. A clip photo from video " To save Taiwan".

3.2 Goal of learning

a.• Cognitive aspect• •

• a• Assessment of identifying the virus, fatal virus can not be classified from appearance. Thus, the learner has to make a judgement base on the information gathered from the plot and then decide how to proceed the process of bacteria identification.

- b• Learning of the skills of bacteria identification, there are skills, e.g. Stain, biochemical test, can be practiced.
- c• Usage of bacteria identification index table, after the preliminary result of biochemical test, the learner needs to learn to use bacteria identification index table for final judgement.

b• Attitude • •

- a• right attitude of science work, through playing the role in the game, the learner can identify the spirit of scientific work, diligence and concentration, as the attitude of being a scientist.
- b• Social caring, since the story has a local background, we hope the learner can improve the caring of local society by solving the problem for local society.

4 Evaluation of our experiment

There are four criteria of the evaluation of the designated software. The criteria is based on the character the teaching subject, human learning theories, and research on user interfaces• Kuittinen, 1998• ; The criteria consist of four types of requirements: subject domain, instructional, user interface design and pragmatic matters. We invited two batches of domain experts, the faculties of Department of Microbiology and industry professionals to evaluate subject domain. They focused on examining if the concept and methods of this domain are generally applied in our software, which means they checked the relevancy to instructional aims. The group of 20 experts showed their positive opinion at the following chart.• Table 1• •The instructional demand is a student-centered approach. We divide a group of 44 college students who are taking food microbiology into two groups. The 22 randomly selected members of test team used our software for average 6 hours in a period of a week. A cognitive examination was taken after one week. The result shows that the test team has better performance in cognitive aspect. Table2• The interactivity, display elements and connections between them are examined as the criteria of user interface. We use questionnaire to test team and found out that the team members show satisfaction of the user interface.• Table 3• As the pragmatic criteria, the hardware and software requirements are evaluated to see if a specific and /or expensive equipment or environment is required to use the software. Our software can be used in a common Microsoft Windows environment plus Pentium compatible personal computer. A learner can run our software either at computer room in campus or at his own PC.

Table 1. The result of experts poll

	number	Min	Max	Average	standard deviation	variance
Can the instructional goal of " assessment of identifying pathogenic bacteria " be reached?	12	3	4	3.67	0.49	0.242
Can the instructional goal of " learning the identification methods " be reached?	12	2	5	4.00	0.74	0.545
Can the instructional goal of " usage of diagnostic table for the identification bacteria " be reached?	12	2	5	4.08	0.79	0.629
Can the instructional goal of " influence on right scientific attitude " be reached?	12	2	4	3.58	0.79	0.629
Can the instructional goal of " influence on social caring" be reached?	12	2	4	3.25	0.87	0.750
Does the content of software cover" common foodborne pathogenic bacteria and their characteristics"?	12	2	5	3.92	0.79	0.629
Does the content of software cover" procedures of identification of pathogenic bacteria"	12	4	5	4.33	0.49	0.242
Does the content of software cover" knowledge for assessment of methods used in bacterial identification"	12	2	5	4.17	0.83	0.697

Table 2. Evaluation on the cognitive improvement of the software

Item		n	Average	SD	F-value	df	t-value
Score of Midterm examination	Control group	23	61.96	6.92	2.54	42	-0.34
	Exp. group	21	62.90	11.03			
Semester score	Control group	23	80.09	9.66	1.00	42	1.59
	Exp. group	21	75.48	9.65			
Cognitive Examination	Control group	23	29.74	6.11	1.09	42	-3.14**
	Exp. group	21	41.29	6.98			
Situated Questions	Control group	23	3.57	2.64	1.04	42	-3.73**
	Exp. group	21	6.57	2.69			
Questions on Microbiological Skill	Control group	23	26.17	5.07	1.08	42	-5.47**
	Exp. group	21	34.71	5.28			

Table 3. Evaluation of user interface of the software

	number	Min	Max	average	standard deviation	variance
I do not need tutoring before I use this software	21	2	5	3.95	0.92	0.848
I can easily know how to jump to next screen	21	1	5	3.76	1.18	1.390
I can exit the software anytime, anywhere.	21	2	5	4.52	0.93	0.862
I do not have the situation that I can not proceed because that I did not memorize the previous information while I use this software.	21	2	5	4.19	0.87	0.762
It's easy to modify my answer before I press the "confirm" bottom	21	2	5	4.10	0.94	0.890
I can receive the system feedback anytime when I use the software.	21	2	5	3.90	0.77	0.590
The system feedback is clear enough and no need to be explained.	21	2	5	3.81	0.81	0.662
I can use the software without reading the user's manual in ahead	21	2	5	4.19	0.87	0.762
I think the execution speed is proper to me.	21	2	5	3.95	0.80	0.648
I can handle the execution speed of my own.	21	2	5	3.81	0.75	0.562
I am satisfied the quality of the video.	21	1	5	3.29	1.01	1.014
I can use the software without knowing how to operate Window NT	20	3	5	4.55	0.60	0.366
Total score	21	39	55	47.81	4.12	16.962

5 Conclusions

We completed situated learning software "To save Taiwan" which attract the user to learn the microbiology knowledge and skills. This interactive software provides multimedia and random plots, which enable user to play the role in the story. It can also served as the tool to convey the right scientific attitude and social caring to learners.

The evaluation of this study showed promising results. It is possible and valuable to adapt situated learning to other disciplines in higher education. A disciplinary can construct the learning process on a situated environment. By using the multimedia software, a learner can learn knowledge as well as the attitude in a near true story. He can then realize the meaning of the knowledge and identify himself with what he has learned and then applied to real environment.

References

- 1• Hsu, H.Y.• "Design of anchored instruction" Audio-Visual Instruction bimonthly. 37(1), page14-24, (1995)
- 2• Yang, C. H.• "The situated instruction theory and hypermedia learning environment"• Instruction technology and media• August, 1995• page41-48• (1995)
- 3• Brown, J. S.Collins, A., & Duguid, P., " Situated cognition and the culture of learning", Educational Researcher, 18,32-41• (1989)
- 4• Cognition and Technology Group at Vanderbilt., "Anchored instruction and its relationship to situated cognition ", Educational Researcher, 19,P2-10, (1990)
- 5• Lazarowitz, R., and P. Tamir.. "Research on using laboratory instruction in science. In: Handbook of research on science teaching and learning". Ed. By D.L. Gabel. P. 94-127. MacMillan Publishing Company, New York., (1992)
- 6• Kuittinen, M. "Criteria for evaluating CAI applications", Computer & Education 31, 1-16, (1998)
- 7• Winn, William,"Instructional design and situated learning: Paradox or partnership?" Educational Technology 33(3), page 16-21,(1993)

An approach to modeling an educational domain

Gennadiy ATANOV
Donetsk Institute of Social Education; DISO, Donetsk, 83000, Ukraine
E-mail: atanov@dongu.donetsk.ua

The paper develops a topic of construction of the normative student model. The subject student model is a part of it representing a sum of demands to the curriculum of the subject, to students' knowledge and skills, and a semantic model of the domain. The subject student models pick out the educational domains from all the multitude of the domains, so the subject model is a model of an educational domain. Examples in physics are given.

Keywords: **student modeling, domain modeling, knowledge, skills, semantics**

1 Introduction

A fundamental concept of modern didactics and pedagogical psychology is the student (learner) model. It arose within computer technologies of education and was provoked by the necessity to formalize our representation about students. Of course such representations had been worked out long before any appearance of computers, and definite formalization of them began together with didactics. But it is computer technologies that gave a new impulse to development of these representations, transformed them into an object of deep investigations, transferred to a qualitatively new level [8,9].

In the widest sense, the student model is our knowledge about a student. There are two sides here: (1) knowledge about how the student is, and (2) knowledge about how we want to see him/her. The first knowledge is determined by the way of analyses of student' s behavior, and it is natural to call it a behavioral student model. It is changing together with the student' s change therefore it is also called dynamic, or current, one. Mechanism of construction of this model is the cognitive diagnostics [9].

Knowledge about how we want to see students, that is, demands to their final state is a normative student model. As a rule, this knowledge is various. It consists of demands to personal qualities of future specialists, their professional qualities and skills, their knowledge and skills in different subjects, characteristics of their physical and psychological state, and so on. The final aim of teaching is achievement of such a state when the behavioral student model concurs with the normative one.

2 The subject student model

A part of the normative student model determining domain knowledge is a subject student model [3]. In knowledge engineering, it is called expert knowledge, or domain model [5,6]. The subject student model picks out the educational domains from all the multitude of the domains, so the subject model is a model of an educational domain, or a model of a subject. Let us note that if the dynamic modeling is quite a developed branch of Artificial Intelligence, the domain modeling is developed to a lesser degree. It is clear, as specialists in Artificial Intelligence, as a rule, are not the ones in any other domain.

Under knowledge they understand the main conformities to natural laws helping us to solve particular problems (production, scientific, economic, and others) [5]. Facts, concepts, algorithms, intercommunications, rules, strategies of making decisions, and so on make up knowledge. The pithy sense of the concept «knowledge» is that knowledge reflects our imagination about domains and expresses a system of concepts, as well as relationships and dependencies between them.

According to the classification, there is a division of domain knowledge into declarative and procedural ones.

The first is statements about properties of the subjects of a domain and relationships between them. The declarative knowledge is often called a factual one, and this reflects its essence very well. The procedural knowledge describes the order and character of the transformation of the domain objects. Its another appellation is rules. In our opinion, it is not quite right, as the declarative knowledge, giving relationships between the objects, is also rules. Thus the procedural knowledge is not simply rules but rules of transformation.

The final aim of instruction is formation of way of acting. The way of acting is realized via skills in the practical activity [7]. The mechanism of this is operation with knowledge (both the declarative and procedural) being displayed in the behavior of a person. Therefore, in a wide sense, skills are attributed to knowledge, namely behavioral one [9]. The procedural knowledge is realized in skills. And sometimes, skills are called the procedural knowledge but, as we could see, the term "procedural knowledge" has been already occupied. Definition "operation knowledge" reflects the essence of the things clearly and in the most unambiguous manner. Thus, the subject student model has to contain skills that are to be formed in the process of instruction. Let us call a list of such skills the operational subject student model.

The declarative component of the domain knowledge makes up a semantic part of it, namely the semantic student model.

One of the distinctive properties of knowledge is that it has a certain structure. It is very important, especially for the instructional material, to define its structure. It is well known that to master a portion of the instructional knowledge is to determine its place in the structure of the instructional material. Therefore, one of the problems while constructing the subject student model must be determination of the subject knowledge structure. Studying the structure of the instructional material is a theme of an independent important and deep investigation. The subject student model must give more or less extended ideas about what the subject knowledge is. Such ideas are an essential part of any curriculum. A usual way here is a thematic approach when themes are enumerated. Let us call a list of themes liable to studying the thematic subject student model.

In teaching, it is very important methodologically to determine which role either knowledge plays and which functions it carries. In other words, it is necessary to fulfil a functional structuring of the instructional knowledge. It can be done with the help of a list of functional rubrics. The functional knowledge will be determined in such a way. Within it, there is knowledge performing both nontransforming functions (for example, facts, conclusions) and transforming ones (algorithms, methods, instructions). The functional knowledge makes up the functional subject student model.

In such a way, we suggest a four component subject student model consisting of thematic, functional, operational, and semantic parts. Such a subject student model in physics is carried out at the physics and didactics of physics department of the Donetsk State University [1-3].

3 The thematic subject student model

The thematic subject student model has been well known for a long time. In essence, it is a usual curriculum of the course, its program. It is built just according to the thematic principle, sections and themes liable to studying are enumerated in it. The model reflects the structure of the course. The program can be worked out in detail to different degree but it is always neither knowledge itself, nor its content but its names. In fact, this is a define characteristic of the subject knowledge, some knowledge about the subject knowledge. Knowledge about knowledge is called metaknowledge. Thus, the thematic subject student model is a metaknowledge.

It is a natural and convenient model for planning and organizing the instructional process. The more, it is an obligatory normative document. Preparation of any course begins with its creation (that is, creation of the course curriculum). Nevertheless, it is excessively general to use it for diagnostics.

As a rule, knowledge in many computer tutoring systems is structured according to the thematic student model.

4 The functional subject student model

The functional subject student model shows which role either knowledge plays; and it is also metaknowledge. It has a define structure in the horizontal direction, which may be given with the help of some rubrics. The role of knowledge and its functions depend on a particular subject. For example, we picked out the following rubrics for physics courses*: concepts, wordings, laws, properties, consequences, conclusions, reasons, formulas, equations, models, methods, and algorithms* [3]. The rubrics have a filling that, nevertheless, also does not reflect semantic of the subject and is metaknowledge.

It is the subject student model that allows working out in details what students must know. Let us give an example from the molecular physics. Students have to know: definitions of the concepts: *mole, thermodynamic system, pressure, temperature, density, concentration, ideal gas, equation of state*, and so on; wording and consequences of: *Pascal's law, Maxwell's and Bolzmann's distributions, Kirchhoff's law*, and so on; deductions of: *the mine equation of kinetic theory, equation of the adiabatic process, law of atmospheres*, and so on.

5 The operation subject student model

As it was noted, the operation subject student model is a list of skills liable to mastering by students. Let us note that skills in education make up a hierarchical system [2]. It consists of five groups of skills: fundamental, methodological, general, inter-subject, subject. Subject skills take the highest position in the hierarchy of skills.

We pick out three classes of the subject physical skills: general, particular, and experimental. The general skills are, on the first hand, methodological ones. Spectrum of the particular skills is far wider, for example, there are more than 200 them in the list in physics. According to the contents of the instructional material, the following skills are picked out*: to find, to determine, to fix, to build, to obtain, to calculate, to compute, to estimate, to distinguish, to pick out, to sort, to take into account, to represent, to traverse, to decompose, to compose, to generalize, to put in practice, to use, to formulate.*

There is a fragment of the list of the skills below:

3.1. General skills

To analyze physical processes and phenomena, to estimate orders of physics magnitudes and determine essential factors, to build physical models, to build mathematical models of particular physical processes and phenomena, to determine boundaries of applicability of the models, and so on.

3.2. Particular skills

3.2.2. Molecular Physics and Thermodynamics

To estimate quantity of particles and their mass in particular conditions, to determine parameters of state of gas, to determine number of degrees of freedom and molecular mass of a gas and mixture of gases, to determine possibility of the use of the model of an ideal gas, to make use functions of distribution to find average values of physics magnitudes, and so on.

Experimental skills are divided into three groups: *to measure physical magnitudes*; *to reproduce independently physical phenomena and processes; experimental particular skills.*

There is a hierarchical structure of the subject skills corresponding to the development of the subject in instruction. Besides that all of them also have a definite structure in the horizontal dimension because they are complicated, or composed, skills. In order to master them, a wide spectrum of skills both of the lower levels and subject is necessary. For example, skill *to solve physical problems* is composed of ten simpler skills*: to pick out the necessary information from the condition of a problem to solve it, to code the condition of the problem in a word form, to draw a picture to the problem, to choice a rational method of solving*, and so on.

6 The semantic subject student model

Semantic knowledge in different subjects is contained in textbooks, other training literature. There are two parts in the content of any textbook: CON-1 and CON-2 [7]. CON-1 is knowledge making up the content of a domain directly, CON-2 is knowledge attending the CON-1 (for example, knowledge from other subjects, interpretations, explanations, examples from life). In fact, it is the CON-1 that is the semantic knowledge of a domain. Nevertheless, this knowledge is not picked out especially, it is distributed all around the textbook, interacts with another knowledge, and is not formalized.

Semantic knowledge represents the declarative component of the subject knowledge as the procedural knowledge is realized in skills (operational knowledge). Thus to construct a semantic student model on the basis of a textbook, it is necessary to pick out domain facts from it and group them in a definite order. According to their structure, facts may be of a great variety. As a rule, they are compound ones. Nevertheless, elementary facts may be picked out that, appearing in different relationships, form the compound facts. General questions of representation of facts in instruction are considered in works [4]. For example, expression "*Translational motion is the motion that all the point of a solid body have identical trajectory*" is a compound fact as it can be represented as a set of the following elementary facts: (1) *a solid body moves; (2) all the point of the body have identical trajectory; some motion is called the translational one.*

One can easily see that the elementary facts do not carry any semantic loading of the domain although they contain domain terms. Only on gathering together in a compound fact they acquire some doma in sense. Such compound facts are finished thoughts and they are represented by finished sentences, or expressions. Let us call them the *semantic* facts. As a matter of fact, the semantic facts are a unit of the domain knowledge, as smaller portions of it have no domain sense. The objects of the expression are concepts, phenomena, processes, laws, principles, theorems, conclusions, consequences, reasons, properties, rules, and so on.

It is the full set of the semantic facts that is the semantic subject student model. The order of their disposition is subordinated to the logic of the development of the course.

Such a semantic subject student model was firstly constructed in Gas Dynamics and than in Physics [1]. Those were very small brochures because there were no calculations, proofs, and explanation in them. Nevertheless, they contained all the statements of the courses. These brochures received the title *semantic synopsis*. As an example, there is a fragment from a physics semantic synopsis below:

3.1. The elementary work of a force is defined as the scalar product of the elementary displacement of the point of the force application.

3.2. The work of a force is defined as a line integral from the elementary work along the trajectory of the point of the force application.

3.3. The unit of the work is one joule that is equal to a work done by a force of one newton on a displacement of one meter.

In the opinion of instructors and students, the synopsis turned out an effective means while consolidating the instructional material, preparing to seminars. It helps to size up the structure of the instructional material, pick out and easily memorize the most essential its moments. It is very important that student remember them for a longer time.

The synopsis allows carrying out fast and regular control students' knowledge during a lecture. In this case, the expressions serve as a base for the open type test tasks being created by missing some keywords in the expressions. Students note a great value of the synopsis while preparing to the examinations when there is a danger do not pick out and master the main statements of the course.

Let us note that the semantic facts are distinctive rules as they define character of relationships between the elementary facts. In other words, they are rules according to which the elementary facts are connected between themselves. This circumstance stipulates possibility to represent the semantic knowledge by means of the production method. It is done with the help of rules of a kind "if A than B" where A and B are some facts. An example of such a representation of the above mentioned definition of the translation motion is given below:

If < *a solid body moves*> and
< *all the point of the body have identical trajectory*>
than <*such a motion is called the translational one*>.

Each of the expressions may be represented in such a way. Thus the production knowledge base of the subject will be constructed. Its constructing is considered in details in work [4]. As our practice shows, constructing production knowledge bases by students while learning is an effective kind of learning activity.

7 Conclusion

An approach to construction of the subject student model as a part of the normative one is described. The model consists of four components: thematic, functional, operation, and semantic. The thematic model gives ideas about the structure of the subject, the semantic one reflects its content, functional one determine what students have to know, and operation one does what students have to be able. The approach allows constructing more detailed current student models and reaching the main aim of teaching, namely forming the way of acting, more successfully.

References

[1] Atanov, G.A., Belaya, T.D., Beshevly, B.I., etc. "The base synopsis in physics". Kyiv, NMK VO, (1993) (in Russian).

[2] Atanov, G.A., Efros, T.I. "System of skills in instruction as a part of the learner model". Proc. of the Intern. Conf. on Computer Assistant Learning CAL-97. Exeter, UK, pp. 369-372, (1997).

[3] Atanov, G.A., Martynovitch, N.N., Tokiy, V.V. "Curriculum of Physics Course as a Student Model". Proc. of the Intern. Conf. on Computer Technologies in Education ICCTE'93. Kyiv, Ukraine, p. 138 (1993).

[4] Atanov, G. A., Pustynnikova, I. N. "Representation and Structuring of Domain Knowledge by the Semantic Networks and Productions Methods". Proc. of the 8th Intern. PEG Conf.: Meeting the Challenge of the New Technologies. Sozopol, Bulgaria,, pp. 392 - 393 (1997).

[5] Brachman, J., Levesque, H.J., Reiter, R. "Knowledge representation". MIT Press, (1992).

[6] Dean, T.L., Allen, J., Aloimonous, J. "Artificial intelligence: Theory and practice". Benjamin/Cummings (1994).

[7] Mashbits, E.I. "Psychological and pedagogical problems of computer assistant learning". Pedagogika, Moscow (1988) (in Russian).

[8] Self, J. "Dynamics of Learner Models. Artificial Intelligence and Education". IOS Press, Amsterdam (1994).

[9] Wenger, Å "Artificial intelligence and tutoring systems. Computational approaches to the communication of knowledge". Morgan Kaufmann, Los Altos (1987).

An Assessment Framework for Information Technology Integrated Instruction

Chuan-Shih Wang* and Chia-Chin Li**
The Institute of Information and Computer Education, National Kaohsiung Normal University
116, Heping 1st Rd., Kaohsiung, Taiwan, R.O.C.
** jason@icemail.nknu.edu.tw **april@ icemail.nknu.edu.tw*

Information technology integrated instruction is the education tendency in the future, and it is also an important issue in the development of education in Taiwan. An assessment framework is needed during experimenting with integrated instruction and when integrated instruction is officially implemented. The framework can help us understand the implementation and provide information for future reference. This article proposes an framework for assessing information technology integrated instruction. The framework includes kernel and periphery parts. Kernel part refers to the whole teaching process, including information technology, curricula, learning materials, instructional strategies, learning activities, and evaluation. Periphery part refers to the surroundings situation, including teachers, students, information specialists, administrators, classroom settings, computer laboratories, campus instruction network, Internet, digital materials, and instruction/learning software.

Keywords: **information technology integrated instruction, technology integration, educational technology, evaluation**

1 Introduction

The rapid development of information technology (IT) has not only brought about major effect on economy and industry but also made a great impact on society and education. In particular, the prevalent use of computers and the rapid development of the Internet have gradually changed our life style and pattern, with their impact on education being unprecedented. Many educators and policy makers believe that technology can be a catalyst for educational reform [3,4,10]. They suggest that the use of technology in classrooms will shift the roles of teachers and students. Teachers will act more like facilitators by helping students access information, process it, and communicate their understanding [4].

Beginning the 2001 academic year, Taiwan will implement phase-by-phase the nine-year integrated curriculum for its elementary and junior high schools [11]. To cultivate students' basic ability to "apply technology and information", the new curriculum will have to emphasize integrating IT into the teaching of various courses. Amid this major reform of curriculum, the Computer Center of the Ministry of Education has planned for the integration of information curriculum with other areas of learning [7]. At the same time, it has selected 18 elementary and junior high schools in which teaching experimentations will be carried out [1]. Therefore, an assessment framework is needed during experimenting with integrated instruction and when integrated instruction is officially implemented. The framework can help us understand the implementation and provide information for future reference.

2 The essence of information technology integrated instruction

The United States has implemented IT integrated instruction for years. Many educators are now actively using technology along with effective teaching strategies to integrate technology into their curriculum [9]. In contrast, IT integrated instruction is still a newly heard noun in Taiwan. Many teachers are unfamiliar with it, and some think of it as another name for computer-assisted instruction (CAI). Information technology has developed rapidly, and the role of IT in education has changed over these years, from being an auxiliary to teaching to being an indispensable tool of education. Therefore, IT integrated instruction is distinguished from CAI.

In IT integrated instruction, information technology is an indispensable tool in the teaching environment because it is integrated into the curriculum, learning materials, teaching and learning [2]. Moreover, the traditional curriculum, materials, and teaching are transformed through the characteristics of information technology: the subject-based curriculum and materials become student-based; the teacher-driven teaching activities become student-centered. Information technology is integrated when it is used in a seamless manner to support and extend curriculum objectives and to engage students in meaningful learning. It is not something one does separately; it is part of the daily activities taking place in the classroom [3].

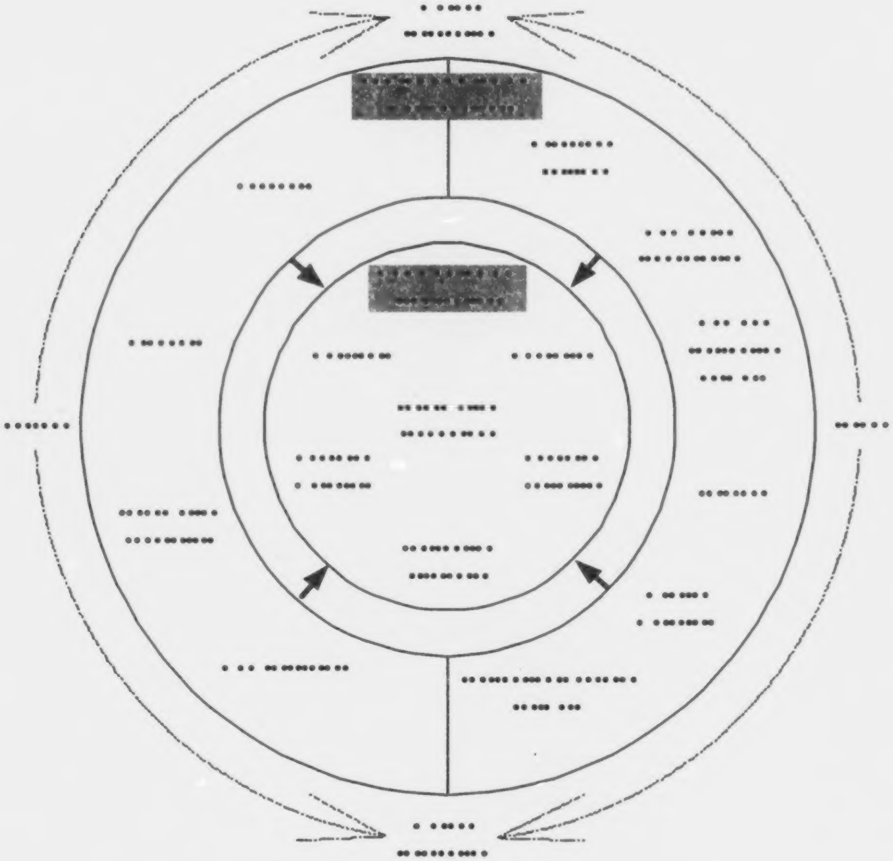


Figure 1. The assessment framework for information technology integrated instruction

Figure 1 depicts the assessment framework of IT integrated instruction. The assessment framework consists of two major parts: Kernel Part and Periphery Part. The kernel part primarily assesses the whole teaching process. Because the implementation of IT integrated instruction will bring about changes to teaching, the aspects to be assessed in this part should include not only the use of IT in teaching but also other perspectives of teaching: curricula, learning materials, instruction strategies, learning activities, and evaluation. The periphery part primarily assesses the teaching environment, learning resources, information equipment, personnel qualities, and administrative as well as professional support. All these factors will influence the outcome of teaching. In particular, IT integrated instruction is in need of supportive and coordinated environmental conditions. There are many perspectives of the periphery part that are related with IT integrated instruction, and ten of them are carefully identified and included for assessment: teachers, students, information specialists, administrators, classroom settings, computer laboratories, campus instruction network, Internet, digital materials, and instruction/learning software.

3 Assessing the kernel part

The kernel part refers to the whole teaching process, and Table 1 shows the perspectives and emphases to be assessed. The aspects of the kernel part are illustrated in the following paragraph.

Table 1. Emphases of the kernel part to be assessed

Perspective	Emphasis
Information technology	The use and role in instruction
Curricula	Subject-based separate curricula or Student-centered integrated curricula
Learning materials	Sequential or problem-based
Instructional strategies	Traditional expository approach or constructivist approach
Learning activities	Teacher-driven or student-centered
Evaluation	Traditional paper-and-pencil testing or multiple assessment

3.1 Information Technology

Information technology may refer to equipment or products, such as computers, network, peripherals, etc. It may also refer to the methods or processes in which the equipment of IT is used to help with the solution of problems. It is the purpose of implementing IT integrated instruction not only to enable students to use the equipment or products of IT but also to use the IT equipment to solve practical problems in learning and life.

In this perspective, we care about how IT is used in teaching and what role IT plays in teaching. The level of the use and role in instruction is developed:

- Nil (level 0)• IT is not used and plays no part in teaching.
- Isolation (level 1): IT is used to teach students how to use IT (e.g. keyboarding, drill-and-practice, word-processing activities). There is no or little connection between IT and instruction content.
- Supplement (level 2): Teachers use IT to assist instruction and students use IT to aid learning occasionally. IT is viewed as a supplement to existing instructional program.
- Support (level 3): IT is needed to complete most learning activities. IT serves as a support to instruction.
- Integration (level 4): Students and teachers can use IT in every-day learning/teaching naturally, confidently, and actively. IT is expansively viewed as tool, process, method to find solutions to authentic problems in any time anywhere.

3.2 Curricula

For elementary and junior high schools, the curricular idea should be life -centered and be in compatible with the development process of students' physical and mental abilities; respect character development, inspire individual potential; cultivate civic qualities, respect the value diversified culture system; enhance science knowledge and skill, meet the requirements of modern life. The design of curriculum should be based on students, on practical experience, and devoted to cultivating the basic abilities required of modern citizens [11]. Therefore, the curriculum should be designed as student-centered integrated or interdisciplinary curriculum, not subject-centered separate curriculum.

IT is used as a tool to help students solve the problem. IT literacy should not be taught as an isolated subject, nor should activities with IT be isolated from other activities in the classroom [12]. Therefore, Taking the students to the computer lab once a week for 40 minutes is not necessarily integration [3]. The teachers should commit to designing student-centered integrated curriculum and integrate IT into the curriculum.

3.3 Learning Materials

Textbooks are the main materials for elementary and junior high schools and the primary learning materials of students. In traditional education, textbooks were unified, having only one version. They were based on subject systems and separate from students' living experience. Besides, it was difficult to innovate them, they could not meet society's requirements for rapid transformation. In 1996 Taiwan implemented a policy which would partially allow publishers to edit and provide textbooks for elementary and junior high school so long as they are approved by the Ministry of Education. On February 3, 1999, VIII (2) of National Education Act was empowered, which unequivocally directs the full use of ministry-approved textbooks for elementary and junior high schools. A new epoch for textbooks was thus heralded in. Teachers should be able to exert their professional autonomy, and students should be allowed a flexible, autonomous learning leeway.

The presentation of learning materials should not be limited to static traditional books, but the characteristics of computer multi-media should be used to present these materials. Static words and pictures, animated pictures and films, voice, acoustic effect and music in combination would make teaching materials lively and motivate students to learn. Besides, they can help students to understand abstract concepts or knowledge and enhance learning effectiveness. If hyperlink technology is used, nonlinear learning materials can be designed so that what students see can be highly individual and not the same. As such, the content of learning materials is flexible, adaptive to individual difference, and compatible with the spirit of individualized learning.

In addition to textbooks, there are many resources on the Internet that can be used as learning materials. These resources can provide "instant", "living" information [8]. Teachers not only can search for information to be included in teaching materials but also can use the real-time information on the Internet to conduct teaching. Students not only can search for information on the Internet but also can conduct independent learning any time, any place by using the learning materials on the Internet.

The use of information technology can make learning materials diversified and lively, make their content flexible and integrated with life. Not only can teachers easily motivate students to learn, but students also can learn happily in a rich teaching situation.

3.4 Instruction Strategies

The teaching strategy of the traditional expository approach is teacher-centered. Students learn what is taught by the teacher, but are given a limited room for thinking, discussion, presentation and exploration. The teaching effectiveness is ostensibly good, and students' performance on examination seems impressive. Yet this approach contradicts the essence of education. In a series of meaningless learning process, what students learn is segmented memory that is extraneous to their experience and cannot be applied in practical situations of their daily life. Nor can they enjoy learning.

Constructive teaching strategy is student-centered. The teacher would first arrange a teaching situation to arouse students' motivation for learning and then would conduce students to explore and think. Through the interaction with peers, the students can gradually integrate the new knowledge into their own system of knowledge and make it an essential part of this system. By this constructive teaching, students must actively learn, while the teacher can only play the role of facilitator, auxiliary, and consultant.

When students use teaching software and browse for Internet resources, they must explore and think actively and construct their own knowledge through the interaction between machine and person and through social interaction. Therefore, the teacher is a "coach" for the student rather than a provider of knowledge. Self-directed learning is an attainable goal for both the student and teacher when IT is integrated in the various content areas [6]. That is, IT integration is most likely to occur in learner-centered classrooms in which the teacher acts as a facilitator [3].

3.5 Learning Activities

Traditional lecture-based and teacher-driven activities can no longer satisfy the needs of modern education. It is not only monotone, also lacks interaction between peers. Learning activities should be student-centered so that the learner can actively work to explore knowledge, clarify concepts, and gradually construct his/her system of knowledge. In addition, project-based and cooperative learning activities should be adopted to allow the learner the opportunity to produce high-level interaction with his/her peers. These activities not only can cultivate a respectful, responsible, and confident attitude and the abilities to express, communicate, coordinate, think, and create but also can increase learning effectiveness.

In cooperative learning activities, students can use computer to communicate and discuss, or use a certain support cooperative work software to facilitate collaboration. Finally, multi-media would be used to present the learning effectiveness of students. Cooperative learning is not limited in local class. It can also be applied across schools, countries, and culture. Therefore, IT enriches the learning activity.

3.6 Evaluation

The traditional evaluation approach primarily depends on paper examinations and determines learning outcome by the scores on the test sheets. This type of evaluation measures only a dimension of knowledge, unable to reflect the wide spectrum of learning process. Future evaluation will become diversified; performance evaluation may be conducted along with paper evaluation; students' self-evaluation, peer evaluation and juried evaluation may be conducted along with teacher' s evaluation; in addition to evaluating learning outcome, the learning process should be evaluated; in addition to quantitative evaluation, qualitative evaluation should be adopted; in addition to evaluating cognitive domain, the evaluation of affective and skill areas should be included. Only such a comprehensive evaluation can reflect the learning process, not only be able to understand what the student has learned but also be able to understand how the learning has occurred.

IT integrated instruction is helpful to the implementation of diversified evaluation. For example, the electronic portfolio is an ideal means of integrating IT into the instruction. It gives the student and teacher an alternative form of assessment. Furthermore, electronic portfolios motivate students to produce quality work, and they also increase students' self-esteem by showcasing their best work [6].

4 Assessing the periphery part

The periphery part primarily refers to the surrounding situations. Table 2 shows the perspectives and emphases to be assessed. The following illustration is based on perspectives.

4.1 Teachers

The teacher is vital in leading teaching activities. Without sufficient information literacy and professional ability, he or she cannot apply information technology on teaching, let alone implement IT integrated instruction. Regarding professional ability, the teacher should be able to integrate IT, in addition to assessing software and digital materials. The attitude is another emphasis of assessment. If the teacher has a positive attitude toward computer, he/she can readily introduce and apply computer on teaching; if the teacher can accept the change in teaching status and role, the implementation of IT integrated instruction would not cause a great impact.

4.2 Students

Students are the chief character in education. In teaching, students should take the initiative to construct their own knowledge. In implementing IT integrated instruction, students can obtain from the process related knowledge and skill and steadily strengthen their information disposition. Gradually students should be able to use, naturally and confidently, computer equipment in active learning and to construct their system of knowledge.

4.3 Information specialists

Teachers are not information specialists. In extensive application of IT to teaching, they will definitely encounter many technical problems that can not be solved by them. In this case, information specialists can support teachers in solving such problems. It is much easier for information specialists with education background to integrate IT with education and guide classroom teachers to implement IT integrated instruction.

4.4 Administrators

Whether administrators feel important about IT integrated instruction is intimately related with the implementation of IT integrated instruction. In addition, if the classroom teacher can gain sufficient administrative support, he or she will be more willing to implement IT integrated instruction.

4.5 Classroom Settings

Generally speaking, teaching activities are conducted indoors. Therefore, the IT equipment in classroom is indispensable to the integration of IT into teaching [14]. The computer and peripherals should not be outdated. The operation system and application software installed in the computer should be appropriate for the use by students and suit the needs of teaching. Moreover, for a class of more than 10 students, a large display device or broadcasting teaching equipment is needed. Finally, it matters whether they are managed properly or whether the fair use by students is ensured.

Table 2. Emphases of the periphery part to be assessed

Perspective	Emphasis
Teachers	Information literacy and professional competency Attitude toward information technology and instructional change
Students	Information literacy Attitude toward information technology
Information Specialists	Professional competency Support for teacher
Administrators	Attitude toward information technology integrated instruction Support for teacher
Classroom Settings	Number of computers and person-machine ratio Grades and fixtures of computer Operating system and application software. Peripherals (e.g. printer, scanner, digital camera) Broadcasting teaching facilities Management
Computer Laboratories	Number of computer labs, number of computers and person-machine ratio Grades and fixtures of computer Operating system and application software. Peripheral (e.g. printer, scanner, digital camera) Broadcasting teaching system Management
Campus Instruction Network	Structure of campus network and network type Domain account File server and database server CD cabinet (perhaps made possible through software simulation)
Internet	Method and speed of Internet connection Actual connection speed Internet server (e.g. web server, proxy server, DNS server, mail server) The mechanism to filter out inappropriate information.
Digital Materials	Digital materials that can be used on the Internet Digital materials created by the teacher
Instruction/Learning Software	Quantity Adaptation

4.6 Computer Laboratories

In a situation in which IT is integrated into teaching, sometimes it is required that one person have one machine. Computer laboratories can justly meet this requirement. Therefore, the management of computer laboratories is an important assessment item and can decide whether the computer equipment can sufficiently support classroom teachers [14]. Moreover, computer laboratories can also provide the most appropriate places for teachers' advancement and students' training of information skill. The equipment in the computer laboratories should not be outdated. Furthermore, there must be a broadcasting system, enabling students to know the whole content of teacher' s lecture in a ready manner.

4.7 Campus Instruction Network

The planning and erection of campus instruction network aims not only to construct an instruction network on campus but also to enable every classroom on campus to connect to the Internet through the campus network. After the campus network is erected, File Server and CD cabinet (perhaps made possible through software simulation) should be erected, in which the teaching software owned by the school is stored so that all the teachers of the school can access to it readily and can apply it to teaching. In addition, the establishment and management of network account is equally important, ensuring the safety of information [14].

4.8 Internet

There are unlimited, un-exhaustive teaching resources on the Internet. If computers can not be connected to the Internet, the application of IT to teaching is compromised. Therefore, it is very important to provide information settings of the Internet. In addition, it is needed to erect Internet-related Server, in particular, Web Server must be erected so that teachers' teaching information and the learning outcome of students can be stored on it to facilitate examination and simulation by teachers and students. Besides, Internet is full of erotic and violent information which is unsuitable to students. It is extremely important to build a mechanism to prevent students from seeing those inappropriate content [14].

4.9 Digital Materials

Digital materials may be presented through information equipment and be used in teaching activities. Therefore, plentiful digital materials should be able to help integrate IT into teaching of various subjects. Therefore many on-line materials on the Internet can be used for teaching purpose. To decrease the amount of time required for browsing and facilitate the use of the materials by teachers and students, on-line index and search systems are also required. In addition, if on-line materials are not appropriate for teaching needs, classroom teachers may create their own materials to be presented on information equipment or use materials created by colleague teachers with the approval from the original designer [14].

4.10 Instruction/Learning Software

Computer Assisted Instruction (CAI) and Computer Assisted Learning (CAL) software is a help to teaching and learning. With more software, teachers are better equipped to apply IT to teaching. This software should be stored on the CD cabinet or File server on the campus network so that teachers can readily use it whenever needed. In addition, if existing teaching software available on campus is evaluated, further information can be provided to teachers [14].

5 Conclusions

That teachers and students can extensively use computers for teaching or learning purpose to heighten teaching qualities and learning effectiveness is the ultimate goal of the infrastructure construction of information education [5]. In other words, integrating computer into teaching of various subjects is the ultimate goal of the Ministry of Education in promoting information teaching [13]. What IT integrated instruction means is not merely to assist teaching by computer but work to integrate IT into curriculum, learning material and learning activities. At this point, the role of teachers begins to transform, from that of a main character to that of a support character. Therefore, the implementation of IT integrated instruction not only harmonizes with the u ltimate goal of information education but also prompt the reform of education so that learning becomes more effective, efficient, and meaningful.

IT cannot be successfully integrated overnight. It needs to take years to complete the process. The process should be carried out in order, stage by stage. Taiwan's IT integrated instruction is germinating. The assessment framework set forth in this article can be used not only to carry out practical evaluation but also serve as reference for development. Teachers' in-service education, pre-service training, administrative support, enriching IT equipment, developing appropriate digital materials and teaching software should be taken to strengthen the perspectives of the periphery part and to diversify the surroundings so that teachers can realize the benefits brought about by IT on education, Accordingly, teachers can apply IT to teaching, gradually infuse IT into learning activities, curricula, learning materials, and adopt student-centered teaching strategies and multi-facet evaluation. All this can lead to the fulfillment of the meanings of IT integrated instruction.

References

[1] Chang, H. Y., "1999 review of implementation of infrastructure construction plan for information education by the Ministry of Education", Ministry of Education Computer Center newsletter, No. 8810, pp. 1-8, (1999).

[2] Chiu, K. H., "Concepts and methods of computer-integrated instruction", Taiwan Education Review, No. 479, pp. 1-8, (1990).

[3] Dias, L. B., " Integrating technology: Some things you should know", Learning & Leading with Technology, Vol. 27, No. 3, pp. 10-13, 21, (1999)

[4] Dexter, S. L., Anderson, R. E., & Becker, H. J., "Teachers' views of computers as catalysts for changes in their teaching practice", "Journal of Research on Computing in Education", Vol. 31, No. 3, pp. 221-239, (1999).

[5] Han, S. M., "Infrastructure construction of information education – acceleration", Information and Education, No. 68, pp. 14-16, (1998).

[6] Hanfland, P., "Electronic portfolios: Students documenting their best work", Learning & Leading with Technology, Vol. 26, No. 6, pp. 54-57, (1999).

[7] Her, J. K., "Viewing the prospects of information education in elementary and junior high schools from the promoting strategy of information education of the Ministry of Education", Information and Education, No. 68, pp. 2-13, (1988).

[8] Lee, C. M., Wu, C. J., & Lin, M. C., "Erection of information education software and material resources center", Information and Education, No. 68, pp. 21-28, (1998).

[9] Levine, J., "Planning strategically for technology integration", Proceedings of Technology and Teacher Education Annual 1998 (SITE '98), Charlottesville, VA, pp. 293-295, (1998).

[10] Mehlinger, H., "School reform in the information age", Phi Delta Kappan, No. 77, pp. 400-407, (1996).

[11] Ministry of Education, "Tentative Guideline for Nine-year Integrated Curriculum for Elementary and Junior High Schools (first learning stage)", http://teach.eje.edu.tw (accessed on April 13, 2000).

[12] Sprague, D. & Dede, C., "If I teach this way, am I doing my job: Constructivism in the classroom", Learning & Leading with Technology, Vol. 27, No. 1, pp. 6-9, 16-17, (1999).

[13] Tu, A. P. & Lin, H. H., "Accelerating the infrastructure construction of Taiwan' s information education: Alternative for expanding internal demand – special interview of Chen Li-hsiang, director of computer center of the Ministry of Education", Information and Education, No. 68, pp. 29-32, (1998).

[14] Wang, C. S., "Criteria for assessing information situation of information technology integrated instruction", Information and Education, No. 77, pp. 36-47, (2000).

An Effectiveness Study of Web-based Application for Mailing List Summary and Review

Satoru FUJITANI* and Kanji AKAHORI**
**Mejiro University College.*
4-31-1, Naka-ochiai, Shinjuku, Tokyo 161-8539 Japan
Tel: +81-3-5996-3127 Fax: +81-3-5996-3125
E-mail: fujitani@mejiro.ac.jp
***The Center for Research and Development of Educational Technology,*
Tokyo Institute of Technology.
2-12-1, O-okayama, Meguro, Tokyo 152-8552 Japan
Tel: +81-3-5734-3233 Fax: +81-3-5734-2995
E-mail: akahori@ak.cradle.titech.ac.jp

This paper reports an effectiveness research of e-mail discussion review support system with summary extraction method. The support system we have developed can automatically extract summary sentences from the normal conversational style language in e-mail messages using reference relationship of e-mails that participants have discussed. One could use the summary sentences for looking back on discussion, and use them as an idea database at a glance. Japanese natural language processing technology has been applied in the proposed method. In order to evaluate the effectiveness of the system, we conducted experiments using a questionnaire and protocol analysis. We compared the two system; the system with and without summary sentences in the table of e-mail content. As a result, following fact-findings were obtained. The system with summary sentences could promote reading strategy such as utilization of table of contents and comprehension of e-mail message structures. On the other hand, the system without summary sentence makes the reader pay attention to the detail information such as name of discussing member.
Finally, we concluded that the system with summary sentence is effective for understanding of relationship among various e-mail messages.

Keywords: **Mailing lists, Natural language processing, Distance learning, Learning environment, Summary sentence extraction, Collaborative learning, Factor analysis, Reading strategies**

1 Introduction

Collaborative learning support environments for network-based discussion appear to be investigated quite often [1][2]. For instance, e-mail is extensively used in the classes for learners' communication.

The research topic we reported here is collaboration support tools that intended for e-mail discussion. For the purpose of sharing of participants' activities on computer networks, we have proposed a summary extraction method along the development of mailing list discussions and an outline presentation tool for mailing list [3][4][7][9]. Japanese morphemes analysis system [8] is applied in our researches. This web-based tool supports reviewing the past discussion on the mailing list. As for results of the summary extraction method, we conducted comparative evaluation between the result of human summarization and of the method. The result suggests that the proposed method can detect major sentences in e-mail articles properly [4].

There is a number of preceding researches on the keyword and summary sentences extraction methods of documents [5][6][15]. But the most of extraction methods in preceding researches applied to well-documented text, like the newspaper manuscript or research paper. On the other hand, this research targets on the conversational style language in text form. For identifying the outline of e-mail discussion, there are many difficult problems in e-mail messages. These are:

- E-mail messages are conversational style language and many summary extraction methods using syntactic information could be not applied.
- The title of e-mail might not be changed as the discussion continues, if so, the title is not meaningful as the summary of documents.
- The method should identify the flow of discussion corresponding with e-mails in order to grasp the topic.

Besides, most of evaluation experiments in summary extraction method with natural language processing technology focus on the validity of algorithm, like adaptability or reproducibility. About analysis of reading comprehension when additional information, e.g. summary, is given, we could refer Ausubel's research on the advanced organizer model [10]. The paucity of reports on sentence comprehension process encouraged us to investigate it.

The purpose of the present paper is to analyze how the summary sentences accomplishes to an actual comprehension process. In this paper we describe an experimental study of e-mail message reading process with or without the extracted summary sentences.

In the first experiment, we investigated e-mail message reading strategies using responses of questionnaire. We conducted comprehension test and reading process analysis. In the reading process analysis, the result was divided into seven factors using factor analysis. The system with summary sentences could promote reading strategy such as utilization of table of contents and comprehension of e-mail message structures. On the other hand, the system without summary sentence makes the reader give attention to the detail information such as names of participating members.

In the second experiment, we analyzed peer discussion processes while reading e-mails on the World Wide Web (WWW) interface. We conducted the comprehension test of the e-mail messages. We also conducted protocol analysis of e-mail reading comprehension. Also hereupon, we compared the results with two conditions, one is a group to which the summary sentence of the e-mail messages was given, and the other is a group without summary sentence of e-mail messages. The results of protocol analysis show some difference in the number of utterance collected during the experiment

2 Summary extraction method along development of discussion

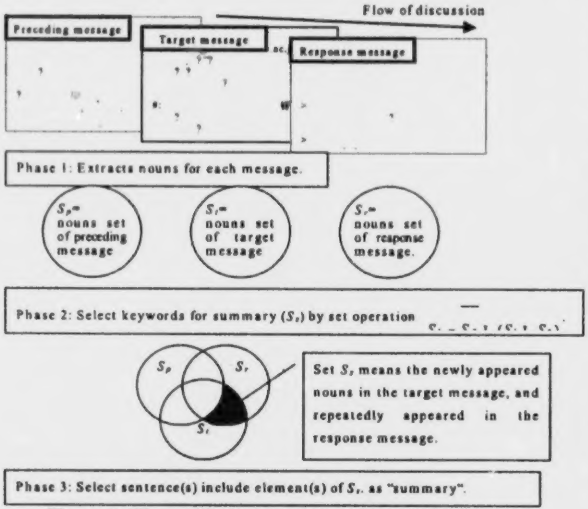

Flow of discussion
Preceding message
Target message
Response message
Phase 1: Extracts nouns for each message.
S_p= nouns set of preceding message
S_t= nouns set of target message
S_r= nouns set of response message.
Phase 2: Select keywords for summary (S_s) by set operation
S_p
S_r
S_t
Set S_s means the newly appeared nouns in the target message, and repeatedly appeared in the response message.
Phase 3: Select sentence(s) include element(s) of S_s. as "summary".

Figure 1: Flow of Summary Extraction Procedure from the target message.

The summary extraction method was discussed in our preceding research [3][4]. In this paper, we de-scribe the outline of the extraction method for better understanding by the readers.

2.1 Idea of the extraction method

We tried the extraction of keywords and summary sentences of the discussion from the document in the mailing list based on the preceding research [11] intended for the discussion such as Netnews. This keyword extraction method can be used in the discussion environment with the following features; (1) The change in the topic does not take place easily in a row. (2) There is a habitual practice that the participants do repeated revisions during the discussion, and uses the quotation appropriately. But although it is limited in our case, e-mail discussion might develop in many ways, and the topic is changeable. The relationship of e-mail message for the keyword extraction between the target message and the past messages is little in e-mail discussion.

Then, in this paper, we set up a hypothesis: Although there was a dependency on the topic, e-mail messages with new information are tempted to encourage responses later. That is, we can treat them as topic making messages in the mailing list. We proposed a summary extraction method that enables pick up those new information as keywords and summary sentences in the messages [3][4]. Figure 1 shows flow of keyword and summary extraction by this method from the content of the message of the mailing list.

However, this summary extraction method supposes both preceding and response messages must be consecutive in the thread. Therefore, we set some assumptions for these exceptions. When the target message is the beginning message in the thread, the title of the message is also used and extracts common nouns among the title of the target message and the body of related messages. On the other hand, when the target message is the last message in the thread, we choose keywords only from the preceding and the target message, and common nouns in both messages is treated as keywords for the target message. Moreover, summary sentences are regenerated when there is a new message in the mailing list.

2.2 Summary generation and WWW display tool

We implemented summary generation and display tool using the proposed summary extraction method. This can be operated on the World Wide Web (WWW) to refer to past messages of mailing list [7]. Fig-ure 2 shows the display of Web page with and without summary sentences. These Web pages fulfill the role of table of contents (TOC) of mailing list. Readers look for contents from the list view with tree structure along continuity of e-mails. They can trace the body of each message from Web link. TOC shows serial number, writer, date of issue, and the title of the e-mail. In Figure 2(b), under the link to the body, summary sentence obtained by the noun set is displayed. When more than one sentence is extracted by the method, it becomes so complicated that the implication of TOC is diminished. So we referred to the procedure widely used in full-text search system [6], the number of displayed sentence is trimmed off to only one sentence that include maximum different number of chosen keywords. We treat that sentence as important sentence for TOC.

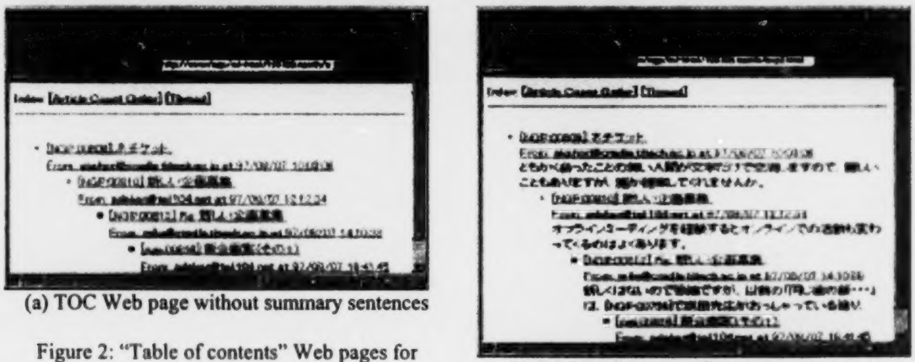
3 Evaluation experiment in the e-mail message comprehension

In this research, we carried out the evaluation experiment on effects of summary presentation while reading past e-mails on the mailing list. We conducted reading comprehension test and factor analysis of reading strategies.

3.1 Methods

3.1.1 Subsubsections

In the experiment, we made the settings resembling the actual Web-based environment of the mailing list.



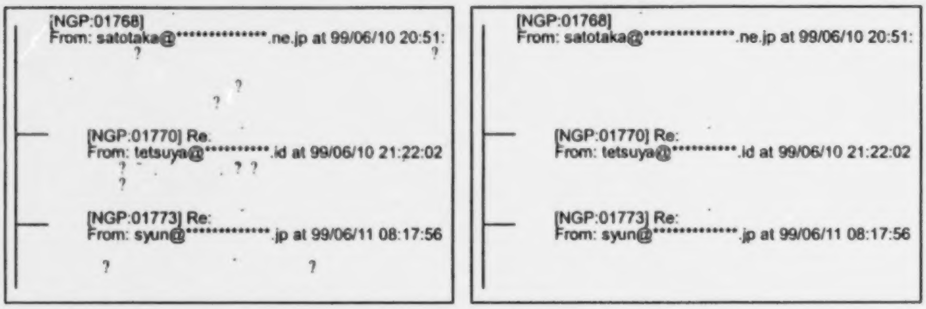
(a) TOC Web page without summary sentences

(b) TOC Web page with summary sentences.

Figure 2: "Table of contents" Web pages for review.

BEST COPY AVAILABLE

We printed out the several e-mail messages in a row, referred to as "thread", and the table of contents (TOC) for the e-mail messages in addition. Figure 3 shows the part of the experimental materials. To the semblance of Figure 2, the summary is generated from the proposed summary extraction method. It appeared in parallel beneath each entry in the TOC, or not appeared. E-mail messages for the summary extraction method consist of nine messages of mailing lists. The topic in the mailing list is the educational use of the Internet for foreign Japanese schools and domestic schools.



[NGP:01768]
From: satotaka@**************.ne.jp at 99/06/10 20:51:
? ?
?
?

[NGP:01770] Re:
From: tetsuya@**********.id at 99/06/10 21:22:02
? ? ?
?

[NGP:01773] Re:
From: syun@*************.jp at 99/06/11 08:17:56
? ?

[NGP:01768]
From: satotaka@**************.ne.jp at 99/06/10 20:51:

[NGP:01770] Re:
From: tetsuya@**********.id at 99/06/10 21:22:02

[NGP:01773] Re:
From: syun@*************.jp at 99/06/11 08:17:56

(a) Printed TOC with summary sentences. (b) Printed TOC without summary sentences.

Figure 3: The part of the printed experimental materials

3.1.2 Procedures

Subjects of the experiment are 56 undergraduate students. None of the subjects know about the mailing list. The printed TOC as described above is affixed in front of the e-mail messages. The printed experi-mental materials were distributed to the subjects, and the researcher explained the experimental setting: "We are going to try to read past e-mails, and catch up with the exchange of the e-mail discussion." In addition, the participants were asked to use TOC positively.

The subjects read these documents for eight minutes. After the eight minutes, the researcher confirmed all the subjects had read the documents once. After that, the subjects were not allowed to read the docu-ments again, and they did the e-mail comprehension test. They had answered the following questions:
1. Write down the name of places which had appeared on the first e-mail as much as you remember.
2. Write down the episode of the first e-mail as much as you remember.
Later, they answered a questionnaire, which was consisting of 28 items with five-point rating scale and space for writing comments. The items were concerning the e-mail reading strategies. In order to make questionnaire, we referred the preceding research about sentence intelligibility [12] and our preceding researches.

3.1.3 Experimental Design

The factor of the experiment materials is presence of summary sentences in the TOC. We can divide the subjects into two levels. 56 subjects were randomly assigned to both two experimental settings of the materials, and were divided into the two groups of 28. Therefore, it is a between-subject experimental design with one factor.

3.2 Results

3.2.1 The comprehension test

In the question 1: "the name of places which had appeared in first e-mail", we compared the numbers of correct answers between two groups. We leave non-response persons off from the analysis. As a result of ANOVA, there was no significant difference in the number of correct answers

Table 1: Extracted factors and results of ANOVA

Name	Ratio	
1. Read the content in detail and memorize	21.5%	**p<.01
2. Use Table of Contents	10.5%	*p<.05
3. Think about the development of discussion	8.7%	
4. Combine their knowledge	7.1%	
5. Think about the theme of discussion	5.1%	
6. Read back and force	4.3%	
7. Write down a memo	3.9%	
Accumulated Explanation Ratio	61.1%	

(F(1,48)=1.065, p>.10).

In the question 2: "the episode of the first e-mail", we have chosen eight words from the message as answer words of the question beforehand. We compared the numbers of appeared answer words between two groups. We also leave non-response persons off from the analysis. As a result of ANOVA, there was no significant difference in the average number of the answer words (F(1,48)=.415, p>.10).

Table 2: ANOVA for Factor Scores

(a) ANOVA for Factor Score of factor 1.

Source	SS	df	MS	F	R^2
Factor	5.61	1	5.61	7.21	0.0098**
Error	38.11	49	0.78		
Total	43.72	50			

**p<.0

(b) ANOVA for Factor Score of factor 2.

Source	SS	df	MS	F	R^2
Factor	4.62	1	4.62	5.99	0.0180*
Error	37.78	49	0.77		
Total	42.39	50			

*p<.0

3.2.2 E-mail reading strategies

The factor analysis with major factor method and varimax rotation method was applied to the 28 questionnaire items concerning strategies of the comprehension for e-mail messages.

As we shown in Table 1, we sequentially named the seven factors. We extracted these factors from the change in the eigenvalue. The accumulated factor explanation ratio was 61.1%. Next, factor score of seven factors was calculated par subjects.
Table 2 shows results of ANOVA. As a result of ANOVA for seven factors, a significant difference was found in the first factor "Read the content in detail and memorize" (F(1,50) =7.212, p<.01) and the second factor "Use Table of Contents" (F(1,50)=5.988, p<.05).

In addition, we compare the score for each item in two groups.

As a result, the group with summary sentences could promote reading strategies such as "Usefully reading TOC help me to know the content of sentences" (t(51)=3.58, p<.01), and "Refer TOC to read the content in the messages" (t(52)=2.76, p<.01). Those who use summary sentences would have tendency that they try to know the relation between the content and the whole structure of the thread.

On the other hand, the group without summary sentences would take reading strategies such as "Pay attention to the participant's name or the name of places appeared on the e-mail while reading" (t(50)=2.34,p<.05), "Read the content carefully and memorize in detail" (t(51)=1.94, p<.10). Thus, they attempted to give attention to the detail information such as names of discussing members.

3.3 Summary of the experiment

In the experiment, there was a significant difference in the e-mail reading strategies while there was no significant difference in the recognition of e-mail contents. Our proposed method is a kind of new information presentation method for the support of e-mail reference. We might say our summary extraction method and display tool for mailing list could help readers to suppress consideration of detail information in the documents. On the other hand, these supports help to maintain the particular contents easier.

4 Protocol analysis of e-mail reading process

From the suggestion in the preceding section, adding summary sentences possibly provide a hint on the e-mail reading strategies. In this section, we examined changes of e-mail reading strategies when having the benefit of summary sentences using protocol analysis. To put it concretely, the subjects answer questions after reading the content of e-mail messages that is displayed on the WWW pages. We have observed the e-mail reading strategies while participants were reading e-mail messages.

4.1. Methods

4.1.1 Experimental materials

We have used 43 e-mail messages of the mailing list for the summary extraction method. Educational use of the Internet in foreign Japanese schools and domestic schools was focused in this mailing list.

Each e-mail message can be traced back and forth from TOC WWW page shown in Figure 2. We have set two conditions; one was in which summary sentences were given, and the other was in which it was not given.

4.1.2 Subjects

Subjects were 20 undergraduate students forming ten pairs. The reason for making group of two is that the subjects could discuss naturally with each other, and therefore, we could collect natural speech proto-cols easily from the conversation [13][14]. They were randomly assigned to two different experimental settings as described previously in this paper.

4.1.3 Procedure of the experiment

The two subjects were seated in front of the computer and were given an instruction for the present experiment by researcher. After the e-mail reading, the subjects were asked to answer some questions on reading comprehension. The subjects were allowed to start reading e-mail messages from anywhere. Then, they read e-mail messages through WWW pages for 20 minutes. After that, they were asked to answer some questions regarding particular content in the e-mail messages within 15 minutes. Finally, they were interviewed about the provision of advance information of the mailing list and the interest on the topic of discussion. None of the subjects know about this mailing list.

4.2. Analysis and Results

In this experiment, we recorded peer protocol with a digital video (DV). Then, we played the recordings and type in the conversation by listening the recordings. During the analysis of utterance, we identify sev-eral reading strategies or procedure for sentence comprehension. For each unit of procedure and strategy, the protocol was classified into the protocol categories [13]. For the classification, we have used the result of the factor analysis as we seen in Table 1. The categories "Read the content in detail and memorize" and "Use Table of Contents" were found to be significantly different on factor analysis. In the first cate-gory, we have considered utterances if the subjects read particular personal name and place name aloud. In the second category, we have considered utterances if the subjects read aloud the summary sentences or pursue continuity of the mailing list by pointing to the TOC. Some subjects pointed using mouse cur-sor's move or their fingers.

Table 3: Frequency of strategies appearance between two categories

Protocol category	With summary	Without summary
1. Read the content in detail and memorize	128	103
2. Use Table of Contents	35	22

Table 3 shows the comparative result with two protocol categories. As the number of subjects is very less, a clear conclusion could not be drawn. But as in Table 3, the frequency of category 1 was relatively higher than that of category 2. As a the result, by means of summary display tool with e-mail messages has been suggested as a method to manage a lot of reading strategies easily. However, though the differ-ence of the frequency does not contradict the results of ANOVA in the previous section, it does not show a significant difference in the comparison of ratios ($\chi^2(1) = 0.67, p > .10$).

In this experiment, a significant difference was not seen in the frequency of the e-mail reading strate-gies. We need to add the number of experiments as well as study the influence of experimental design in peer conversation.

5 Conclusions

The results of this research may be summarized as follows:

1. We applied the summary extraction method for mailing list, and analyzed e-mail reading comprehen-sion and reading strategies for reference. Although the result is limited to the e-mail messages we used, the display of e-mail summary sentences affects experimental subjects' reading strategies. On the other hand,

the result of comprehension test does not show significant differences. We may con-clude at this point that the method of summary sentence extraction is effective in understandings of relationship of e-mail messages.

2. The influence of summary display on the e-mail reading strategies was examined from the analysis of utterance protocol. The use of Table of Contents WWW page along with e-mail summary sentences does not make a difference in the frequency of utterances, but preferential trend for the use of e-mail summary sentences was observed.

As a problem yet to be solved in the future, we are interested in examining the effectiveness of reading strategies when e-mail messages are posted and read in real time.

Acknowledgement

Our special thanks are due to Madhumita Bhattacharya, Ph.D., the National Institute of Education, Singapore, for reading the manuscript and making a number of helpful suggestions.

References

[1] Kusunoki, F. & Sayeki, Y., "We can learn because of the opinions different each other", Journal of Information Processing Society of Japan, Vol. 40, No. 6, pp. 564-568, (1999).
[2] Inaba, A. & Okamoto, T., "The Network Discussion Supporting System Embedded Computer Coordinator at the Distributed Places", Educational Technology Research, Vol. 18, Nos. 1-2, pp. 17-24, (1995).
[3] Fujitani, S. & Akahori, K., "A Summary Sentence Extraction Method for Web-based Mailing List Review Application and Its Effectiveness Study", Advanced Research in Computers and Communications in Education (ICCE99), G. Cumming et al. (Eds.), IOS Press, Vol. 1, pp. 327-334, (1999).
[4] Fujitani, S. & Akahori, K., "A Summary Sentence Extraction Method of E-mail Discussion and Its Web-based Application to Mailing List Review", Educational Technology Research, Vol.23, Nos. 1-2, *In printing*, (2000).
[5] Sasaki, I., Masuyama, S. & Naito, S., "Proposal on sentence extract method which pays attention to vocabulary coherency", Technical Report of Information Processing Society of Japan, 93-NL-98, pp. 65-72, (1993).
[6] Sumita, K., Tomono, T., Ono, K. & Miike, S., "Generation of Automatic abstract with document structural analysis, evaluations as retrieval presentation function", Journal of The Institute of Electronics, Information and Communication Engineers, D-II, Vol. 78-J, No. 3, pp. 511-519, (1995).
[7] Fujitani, S. & Akahori, K., "Improvement of content summary extraction method along with development of discussion about document of mailing list summary system", Proceedings of 14th annual conference of Japan Society of Educational Technology, 2pB02-3, pp. 691-692, (1998).
[8] Kurohashi, S. & Nagao, M., "Japanese morpheme analysis system "JUMAN" version 3.61", Graduate school of information science, Kyoto University, (1999).
[9] Ken'ichi Fukamachi, "fml" Mailing List Server Package, http://www.sapporo.iij.ad.jp/staff/fukachan/fml/index-e.html (accessed on August 1, 2000).
[10] Ikeda, S. & Tanaka, S., "improvements of experiment diagram in preceding organizer research", Reading sciences, Vol. 29, No. 2, pp. 41-55, (1985).
[11] Ishihara, M. & Akahori, K., "Developments of discussion summary system for discussion support with problem", Journal of Japan Society of Educational Technology, Vol. 22, No. 1, pp. 1-12, (1998).
[12] Uchida, N., "Is the sentence understanding process "top down" or "bottom up?" ": In Shun-ichi Maruno, some controversies in cognitive psychology, Kyoto: Nakanishiya publication, pp. 165-188, (1998).
[13] Kaiho, H. & Harada, E., "Introduction of protocol analysis", Tokyo: Shin-yo-sha, pp. 118-134, (1993).
[14] Madhumita, & Akahori, K., "An Evaluation Method for Audiovisual Software Based on Protocol Analysis", Media and Education, Vol. 1, pp. 19-27, (1998).
[15] Firmin, T. & Chrzanowski, M. J., "An Evaluation of Automatic Text Summarization Systems, Advances in Automatic Text Summarization", The MIT Press, pp. 325-336, (1999).

An Empirical Study of the Design and Use of a Multimedia Composition-Making System for Children

Kaori Iwashita*, Shinya Kawakami and Bipin Indurkhya**
Department of Computer Science, Tokyo University of Agriculture and Technology,
Koganei City, Tokyo, Japan, tel: 81-42-364-3311
**e-mail: kaorii@ma.neweb.ne.jp, **e-mail: kawakami@fairy.ei.tuat.ac.jp*

In this paper, we describe our experiences in designing and using a multimedia composition-making system for children. The system allows children to make compositions using pictures, sounds and text. Moreover, it also allows pictures in the composition to be animated. We experimented with children using this system in three different settings. In the first setting, no topic was assigned to the children. In the second and third experiments, children were given a topic (different for each experiment) for composition related to their activity. We present here the results of our experiments and comment on how the constraints imposed by the topic affect children's expressive abilities.

Keywords: **animation, children's expressive abilities, constraints and creativity, multimedia composition.**

1 Introduction

In recent years, many researchers have studied multimedia techniques and have incorporated them into various educational systems. For example, Silva [5] described a multimedia soundscape system, "They Are Catching Sounds in the Park!", for environmental education. In this system, children search for sounds by clicking anywhere in the picture. When they click an appropriate object, its associated sound and information are presented to the children. Brna [1] proposed a system for composing and writing stories via cartoons. Harviainen [2] presented a co-authoring system in which many users work together to compose a story. Ishii [3] and Kawakami [4] have developed other systems for making stories with multimedia. All this research demonstrates that multimedia has much potential for stimulating the ability of children to express themselves. In particular, we find that children can express their creative and imagined ideas much better with pictures and words than with words alone. Moreover, if we add an ability to attach sounds to pictures, and allow pictures to be animated, then this expressive power increases considerably.

Motivated by these factors, we have developed a system to help children write multimedia compositions, and have tested it with children in three different settings. In this paper, we describe our system and report on our experiences with children using the system.

2 Prototype of the System

We developed a prototype of a multimedia composition-making system. Using our prototype,

- Children can express their thoughts and ideas via pictures, sounds, text, and animation sequences. In our system, children must first choose a background scene, in which they can then insert picture objects, sounds, and text.
- Except for the background, children can attach sounds and text to picture objects, and can animate them to make a multimedia composition.

This system has two modes: a ' Set up' mode for the teacher or supervisor to allow them to determine which background scenes, picture objects, sounds, etc. are made available to the children for writing a composition, and a ' User' mode for children to write compositions.

The ' Set up' mode has the following two functions:

1) Select situation: Set the context or theme for the composition.
2) Edit situation: Set the categories of background scenes, picture objects and sounds corresponding to a theme.

The ' User' mode has the following seven functions:

1) Select background scenes.
2) Select picture objects.
3) Select sounds.
4) Write text.
5) Animate composition.
6) Save composition.
7) Load composition.

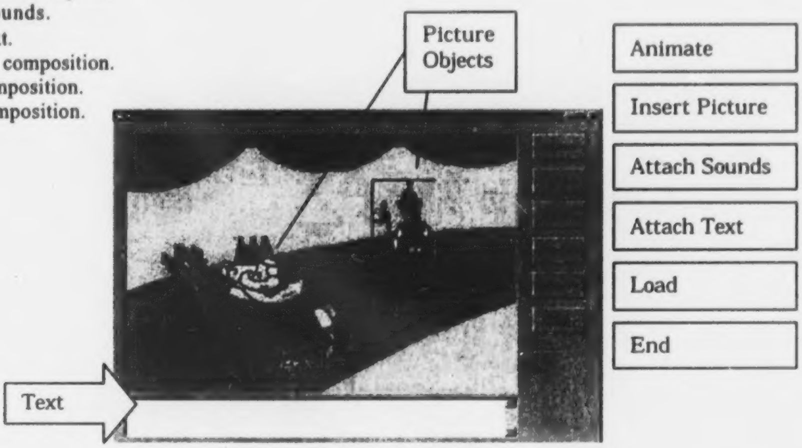


Figure 1. An example of the main window

By double clicking on a picture in the main window, the sound attached to that object (if any) can be heard. Also, when the picture of an object is selected in the main window, the text attached to it is displayed in the text box.

The animation module has five functions: show picture, hide picture, output sound, show text, and move picture.

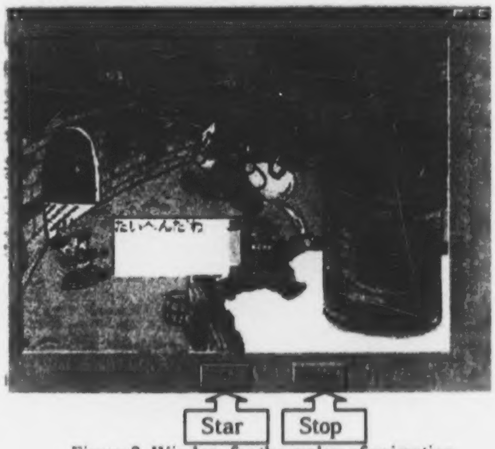
To replay animation, children click the ' start' button in the animation window. When the button is clicked, the system starts the animation sequence as previously specified. It replays each action one by one, but it pauses when the action is ' show text' . To continue from there, the user needs to click the ' start' button again.

3 Experiments with the system

We did three different experiments in which children used our system. In each experiment, the setting and the tasks given to children were different, as described below.

3.1 Experiment I

In this experiment, we studied a constraint-free use of the composition system. The children were not given any specific topic of composition, and they could use the system any way they like to create any composition freely. We prepared 54 background scenes, 185 pictures and 68 sounds. Because no topic was given, children chose a variety of themes.



たいへんだわ

Figure 2. Window for the replay of animation

3.2 Experiment II

In this experiment, we introduced a constraint by giving a topic of composition to the children, and analyzed the generated compositions. The experiment was done at an activity center for children. At this center, children of each grade come periodically, and play or make some handicraft. One of the handicraft projects for third-grade children was making kites. So, the following week, we asked the children to make a composition about kite making. For the experiment, we prepared a version of the system with six backgrounds scenes of craft rooms. Three of these were scenes with kites in them, and the others were scenes with only a room and tables without kites. We also prepared 68 pictures and 35 sounds appropriate for kite-making activity.

3.3 Experiment III

In this experiment, we introduced a tighter constraint by giving a more specific topic of composition to children, and studied its effect. We asked the children to make a composition for the story "The coward king and robber" (original title in Japanese). The original story is written in Japanese. At the same activity center for children used in Experiment II, the children made an extended version of this story, made a picture book to illustrate various scenes in the story, and then told the story using these pictures at their Christmas party. The week following the party, we asked the children to make a composition for this story using our system.

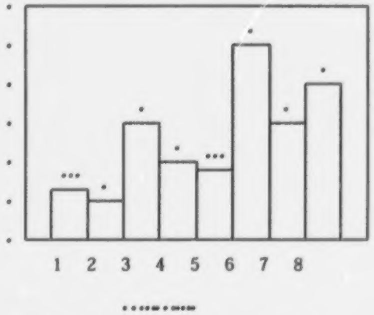


Figure 3. Differences between the composition picture and the original picture from the picture book (for each background scene)

For this experiment, we prepared a version of the system with eight background picture scenes related to the story. We also prepared 66 picture objects and 33 sounds appropriate to the story.

In this experiment, we were interested in analyzing the differences between compositions made using our system and the corresponding pictures in the picture book for this story that the children had made earlier. We used the following method for computing the difference. The picture objects were grouped into ten categories, and the difference between two pictures (with the same background scene) was calculated as follows:

> For each picture object category: if there is an object of that category in both the pictures, we say that the difference between the two pictures with respect to that category is zero. If one picture has an object from that category, and the other has none, we say that the difference with respect to that category is one. The difference between two pictures is the sum of the differences over all ten categories.

Figure 3 shows the result of applying this procedure.

We see that the differences for the climactic scenes (scenes 6• 7) are higher than the other scenes.

3.4 Discussion

An analysis of the compositions produced in the three experiments is shown in Tables 1, 2 and 3. Table 1 shows the average number of compositions produced by a participant in each experiment. We see from it that the children were most expressive when the topic was most constrained (Experiment III).

Table 1. Number of compositions per participant

	Experiment I	Experiment II	Experiment III
Number of participants	11	7	5
Number of compositions per participant	1.3	1.4	4.6

Table 2 shows a more detailed analysis of compositions with respect to how multimedia features of the system were used.

Table 2. Number of multimedia features per composition

Multimedia feature	Experiment I	Experiment II	Experiment III
Picture objects	3.6	11.2	6.9
Sound attachments	1.1	2.4	1.6
Text attachments	-	1.1	1.6
Animation	1.0	2.8	9.9

Here we see that picture and sound attachments are used most in Experiment II. This may be because in this setting children were describing a situation using generally one page (screen). For this, they used many objects and sound attachments to provide information about the depicted situation. We also see that text attachments and replay actions were used most in Experiment III. It might be because in this setting they were describing a story, for which text attachment is a useful way to express characters' utterances, and animation is useful to express characters' movement. We also would like to point out that in Experiment III there were fewer picture objects and sound attachments per composition. This is because to show the flow of events in the story, children made many compositions (Table 1).

Table 3. Analysis of animation operations per composition (in percent)

Animation operation	Experiment I	Experiment II	Experiment III
Show picture	0	0	53
Hide picture	0	0	4
Output Sound	13	0	10
Show text	-	0	15
Move picture	87	100	18

In this table we see that in Experiments I and II, mostly the 'move picture' operation was used. In composing a story, however (Experiment III), the 'show picture' was used most. We also found that the 'hide picture' operation was rarely used.

4 Conclusions

From our experiments, we see that the multimedia features of the composition-making system are most useful in illustrating a story or a narrative. Sound and text attachments and animation operations can be very helpful in expressing movement of characters and the progression of events in a narrative. We also found that many children are most expressive when they are given a focus of composition.

From these results, we propose that a system such as ours can be used in the classroom for children to make compositions about field trips and class excursions. For each trip or excursion, the teacher can set up the system appropriately by choosing relevant picture and sound libraries before children use the system. In this way, we feel that our system can provide a step forward from Silva [5]. Children are more actively involved in making compositions with our system than in exploring with 'They are catching sounds in the park!"

Acknowledgements

We would like to thank all the children who participated in the experiments, and the staff at the children's center for their cooperation. We thank Professor Yoshiyuki Kotani, and members of the Kotani-lab for their help and cooperation during this research. Some pictures used in the background of Experiment III were taken from [6].

References

[1] Brna, P., Martins A., & Cooper B., "My First Story: Support for Learning to Write Stories", Advanced Research in Computers and Communications in Education, pp. 335-341, 1999.

[2] Harviainen, T., Hassinen, M., Kommers P., & Sutinen, E., "Woven Stories: Co-authoring over the Internet", Advanced Research in Computers and Communications in Education, pp. 285-292, 1999.

[3] Ishii, Y., Indurkhya, B., Inui, N., Nose, T., Kotani, Y., & Nishimura., H., "A System Based on Rodari's 'Estrangement' Principle to Promote Creative Writing in Children", ED-MEDIA & ED-TELECOM 98,

Vol. 2, 1685-1686, 1998.

[4] Kawakami, S., Indurkhya B., Inui, N., & Kotani, Y., "A Story Making System for children", Advanced Research in Computers and Communications in Education, 359-360 1999.

[5] Silva, M.J., Silva, J.P., & Hipolito, J., ""They Are Catching Sounds in the Park!" Exploring Multimedia Soundscapes in Environmental Education", ED-MEDIA & ED-TELECOM 98, Vol. 2, 1274-1279, 1998.

[6] Yamawaki, K., & Miyamoto, E., "Yowamushi o-sama to to-zoku", Kyoiku Gageki, 1989.

Applicability of an Educational System Assisting Teachers of Novice Programming to Actual Education

Hiroyuki Suzuki*, Tatsuhiro Konishi and Yukihiro Itoh****
* *Graduate School of Science and Engineering, Shizuoka University*
** *Faculty of Information, Shizuoka University*
Johoku 3-5-1, Hamamatsu, Shizuoka, Japan 432-8011
Tel: +81-53-478-1474 Fax: +81-53-478-1499
E-mail: {h-suzuki, konishi, itoh}@cs.inf.shizuoka.ac.jp

In this paper, we propose a technique for reducing processing time during program evaluation, and examine processing time of evaluating programs of which sizes are relatively large in novice programming courses. We proposed a method of constructing an automated evaluation system assisting teachers teaching novice programming. Our system evaluates learners' programs by comparing them with a standard algorithm representing teacher's intentions. By using our system, teachers can easily pick up learners' defective programs. We constructed a prototype system, and examined whether the system can evaluate programs actually submitted by learners. We confirmed that it could evaluate the programs validly. However we found that we should improve the processing time after evaluating various programs. In order to reduce processing time, we extend the matching algorithm using two ways. As a result, processing time is improved without spoiling the accuracy of matching. After that, we design a model course of novice programming based on actual courses in our university. And we examine the relation among program size, arbitrariness of teacher's intention and processing time. Then we confirm that the processing speed of our system is fast enough to be used in actual education environment.

Keywords: **educational system assisting teachers, automated evaluation system, program diagnosis, experimental evaluation.**

1. Introduction

By using program diagnosis technique, many programming education systems have been developed[1][2]. Most of them are designed to help learners, not the teachers. We think it is necessary to help teachers in order to give learners better advice. It needs much effort for teachers to evaluate many programs. So we constructed a prototype system assisting teachers teaching novice programming[4]. We have designed a model course on the basis of actual novice programming education course. Then, we have examined whether the system can evaluate programs written by learners. We confirmed that it could evaluate the programs validly[5]. However we found that we should improve the processing time after evaluating various programs. In this paper, we propose a technique for reducing the processing time (section 3), and examine processing time of evaluating programs of which sizes are relatively large in novice programming courses, then confirm that the processing speed of our system is fast enough to be used in actual education environment (section 4).

2. Our previous work

Generally, teachers teaching novice programming arrange goals for their exercises, and set exercises related to the goals. We call these goals "*teacher's intentions*". They evaluate whether each program submitted by a learner achieves the goals or not, and advise the learners according to the result of the evaluation. However, it needs much effort for them to evaluate many programs with various bugs. So we support them by developing an automated evaluation system classifying programs which perfectly satisfy *their intentions*, which partially satisfy *their intentions* or do extra work, and which don't satisfy *their intentions*. Therefore they only have to check the unsatisfied programs carefully.

We found that most of *teacher's intentions* can be represented with standard algorithms to solve exercises. So we use the standard algorithms for inputting *teacher's intentions*. We designed an algorithm representation based on PAD expression. We call the representation "Extended PAD". By using the Extended PAD, teachers are allowed to use the following structures in order to represent arbitrariness included in *their intentions*.

Non-ordering structure: It represents arbitrariness on the order among tasks,
Alternative structure: It represents arbitrariness on method to achieve a goal.

The Extended PAD consists of two types of elements: elements which correspond to a Pascal operation or control structure, and which correspond to a sequence of Pascal operations. We call the previous elements "primitive operations", and the other "macro operations".

We developed a method matching learners' programs with a standard algorithm. According to this method, the system tries to check correspondence of every combination of statements in a learner's program with the statements in a standard algorithm. If it judges that a statement in a learner's program matches with a statement in a standard algorithm, it makes a hypothesis on a correspondence of these statements and correspondences of variables referred by the statements. Then it continues matching the other statements on the basis of the hypothesis. As the matching process succeeds, the hypothesis grows up. Generally, possible correspondence of variables is not unique. So the other hypotheses containing the other correspondences of variables are set up at the same time. According to the result of matching, it outputs its judgement, "perfect match", "partial match" or "no match" based on the most plausible hypothesis. "Partial match" means that a learner's program doesn't match with a standard algorithm perfectly, but both the ratio of matched statements to the whole in the learner's program and the ratio of matched statements to the whole in the standard algorithm are higher than each threshold we defined.

3. Improvement of processing time

In order to reduce processing time, we should re-consider a method of matching programs. The system outputs the result of judgement on the basis of the most plausible hypothesis. The others are rejected. So if the system has an ability to find useless hypotheses on the way during matching process and avoid checking the correspondence of statements on the basis of the useless hypotheses, processing time must decrease.

So we extend the matching method as follows:

1) When the system intends to make new hypothesis containing correspondence of a new combination of statements in a learner's program and a standard algorithm, it calculates the ratio of matched statements to the whole under the assumption that all of the following statements will be matched perfectly. If the ratio cannot reach the threshold, the system doesn't make the hypothesis and omits the process of matching the following statements based on the hypothesis.

2) After the system has matched whole statements on the basis of a certain hypothesis, it tries to match statements on the basis of another hypothesis. In such a case, when the system finds that the ratio of matched statements to the whole cannot reach the ratio of previous trial, under the similar assumption to 1), it stops matching the following statements.

As a result, processing time is improved without spoiling the accuracy of matching. We confirm that evaluation of programs is not changed by the extension. Table 1 shows improvement of processing time necessary to judge the programs. Exercise (1), (2) and (3) are illustrated in Table 2. The computer system used for both experiments before and after the extension is an Engineering Workstation JU2/2300 (CPU: Ultra SPARC-II (300MHz) * 2, SPECint95: 12.3, SPECfp95: 20.2, Operating System: SunOS5.6, Made by: Japan Computer Corp.).

Table 1: Improvement of processing time.

	Number of programs	Average time of processing [sec/program]	
		Before extension	After extension
Exercise(1)	42	184.98	1.57
Exercise(2)	56	1.43	0.13
Exercise(3)	49	109.06	1.10

4. Applicability of our system to actual education environment

In order to discuss applicability of our system to actual scene in education, we design a model novice programming course based on actual courses in our university[5]. The exercises in the course are seen in Table 2. We use programs submitted by learners in the actual courses of our university.

We write each standard algorithm of exercise within the following restriction: the number of steps of

Extended PAD must be less than twice the number of steps of a standard program for corresponding exercise. The reason is that teachers don't prefer writing more detailed standard algorithms because of their costs.

The computer system used for this experiment is also the Engineering Workstation JU2/2300.

Table 2: The exercises in the model course.

Exercise(1)	There are several birds and tortoises. Find the number of them when the following conditions are given: (1) Sum of the heads of birds and tortoises. (2) Sum of the legs of birds and tortoises.
Exercise(2)	A character datum that is an uppercase character will be input by user. Convert it to lowercase.
Exercise(3)	A hexadecimal number will be input by user as two digits of character datum "0-9" or "A-F". Convert it to a decimal number.
Exercise(4)	Solve an equation "ax^3+bx^2+cx+d=0" by using the Newton method.
Exercise(5)	Sort integer data in an array by using the straight selection sort algorithm.
Exercise(6)	Solve simultaneous equations by using the Gaussian elimination.

4.1 Result of experiment

In order to evaluate processing time, we must consider the following factors: program size of standard algorithms and one of learners' programs, arbitrariness of *teacher's intentions*, judgement of learners' programs. Therefore we examine the relation among these factors and processing time. Table 3 shows:

- Program size of a standard algorithm and arbitrariness of *teacher's intention*.
- The number of learners' programs and average of their program size.
- Judgement of learners' programs, and the average processing time.

We measure the program size by the number of statements, blocks and variables, and the arbitrariness by the number of alternative structures and non-ordering structures including a standard algorithm. The judgement means the number of learners' programs that are judged "perfect match", "partial match" and "no match" by our system.

As program size increases, the number of combination of statements in a learner's program with the statements in a standard algorithm also increases. At the worst case, the number of the combination increases proportionally to factorial of number of the statements. However Table 3 shows gentler increasing. From the result, we think our extended matching method works well. Exercise (4) needs rather long processing time. We think that the number of statement per block is larger than the other exercises, and most of statements in the block have dependencies, i.e. a variable assigned some value by an assignment statement is often referred in the following statements in the same block. In such a case, the system must compound formulas and the process of compound needs rather long time. However, we check how often such an exercise appears in actual textbook[3] for novice programming and find that only one exercise.

Table 3: Relation among program size, arbitrariness of standard algorithm and processing time.

	Standard algorithm					Learners' programs				Judgement of Learners' programs			Processing time [sec/program]	
	Number of:					Average of:				Number of:				
	Statements	Blocks	Variables	Alternative	Non-ordering	Programs	Statements	Blocks	Variables	Perfect match	Partial match	No match		
(1)	5	1	4	0	0	42	9.2	9.1	1.4	0	4	38	0.96	
(2)	4	1	2	0	0	56	9.3	2.1	3.1	3	17	36	0.30	
(3)	11	5	4	0	0	49	19.7	7.7	5.9	0	0	49	1.50	
(4)	9	4	5	0	0	14	9.9	2.0	6.6	7	1	6	6.23	
(5)	10	4	5	0	0	14	9.8	4.0	5.1	1	10	3	0.30	(*)(#)
	10	4	5	1	0	14	9.8	4.0	5.1	1	10	3	0.31	(*)
	10	4	5	2	0	14	9.8	4.0	5.1	1	10	3	0.43	(*)
	10	4	5	3	0	14	9.8	4.0	5.1	1	10	3	0.44	(*)
	10	4	5	0	1	14	9.8	4.0	5.1	1	10	3	0.35	(#)
	10	4	5	0	2	14	9.8	4.0	5.1	2	9	3	0.52	(#)
(6)	28	12	11	0	0	24	27.3	11.8	11.0	1	11	12	9.87	(*)
	28	12	11	11	0	24	27.3	11.8	11.0	1	11	12	31.00	(*)

We evaluate our system on another standpoint. As arbitrariness of *teacher's intention* increases, possible combinations of statements in a learner's program with the statements in a standard algorithm also increase. We prepare some standard algorithms for the exercise (5) and (6), and process actual programs of learners. The result is seen in the lines with (*) and (#) in Table 3.

We prepare a standard algorithm including three alternative structures representing two methods to achieve a goal. At the worst case, the number of combination of statements in a learner's program with the statements in the standard algorithm increases 8 (=2^3) times. However Table 3 shows 1.5 times increasing. We also measure processing time by using a standard algorithm of exercise (6) including 11 alternative structures representing two methods. Although it seems that processing time increases 2048 (=2^11) times, Table 3 shows only 3 times increasing. Similarly, on exercise (5), we prepare a sample of Extended PAD including 2 non-ordering structures representing arbitrariness on the order between two tasks. In this case, it seems that processing time increases 4 (=(2!)^2) times. However Table 3 shows 1.8 times increasing. We think that the reason why the processing time isn't so increased is that our extended matching method works well. When our system evaluates using standard algorithms that include alternative structures or non-ordering structures, useless hypotheses are rejected at earlier stage of matching process.

In the next section, considering the result shown in Table 3, we discuss applicability of our matching method to actual education.

4.2 Estimation of processing time for actual exercises in novice programming

We survey model programs in a textbook[3], and write standard algorithms considering alternative coding methods or alternative order of statements. Then we investigate the program size, numbers of alternative structures and numbers of non-ordering structures. The result is seen in Table 4.

We can regard that our matching algorithm processes even programs belonging to the most complicated class in actual education within practical processing time. The reasons are as follows:

- The number of statement in programs of high level is less than the exercise (6) on average. And the largest number of statement is equivalent to the exercise (6).
- The number of alternative structure is almost 4 for programs of middle or high level.
- The number of non-ordering structure is less than 2.
- Therefore we think that our system can evaluate the most complicated program in the textbook with processing time similar to exercise (6) (31.00s/program).
- In fact, if a teacher takes care of 100 students in a class, the time necessary to evaluate their programs by our system is only 50 minutes or so. We think this is practical enough.

Table 4: Program size of exercises in a standard textbook of novice programming.

Exercise		Number of programs	Number of statements	Alternative structures		Non-ordering structures
				Iteration	Others	
Basic level	(the four rules of arithmetic, etc.)	19	8.5	1.1	0.2	1.2
Middle level	(sorting, etc.)	34	17.9	4.0	0.5	1.1
High level	(searching trees, etc.)	14	20.9	3.5	0.3	1.1

5. Conclusions

In this paper, we extend our matching algorithm to improve the processing time. Through the examinations and the discussion about processing time, we confirm that our system can evaluate actual programs in novice programming in practical time. Now, we are constructing a graphical user interface for describing standard algorithm. We will evaluate usability of our system after constructing it.

Acknowledgements

This research was supported in part by Grant-in-Aid for Scientific Research (c)(11680216) from Japan Society for the Promotion of Science.

References

[1] Anne Adam & Jean-Pierre Laurent, "LAURA, A System to Debug Student Programs", Artificial Intelligence, Vol.15, pp.75-122, (1980).

[2] Haruki Ueno, "Integrated Intelligent Programming Environment for Learning Programming", IEICE Transactions on Information and Systems, Vol.E77-D, No.1, pp.68-79, (1994).

[3] Nobuo Yoneda, Teruo Hikita & Takafumi Sakurai, "Pascal Programming"(in Japanese), SAIENSU-SHA Co.,Ltd., (1991).

[4] Tatsuhiro Konishi, Akihiro Suyama & Yukihiro Itoh, "Evaluation of Novice Programs Based on Teacher's Intention", Proceedings of ICCE'95, Singapore, Dec. 5-8, pp.557-566, (1995).

[5] Yukihiro Itoh, Tatsuhiro Konishi & Hiroyuki Suzuki, "On Experimental Evaluation of an Educational System that Supports Teachers of Novice Programming", Proceedings of ICCE'98, Beijing, China, Oct. 14-17, Vol.2, pp.234-238, (1998).

Cooperative Monitoring System using Mobile Agent

Young-Gi Kim, Sun-Gwan Han, Jae-Bok Park
Inchon National University of Education
Dept. of Computer Education
Tel +82-32-540-1283
#59-12 Geysan-dong Geyang-gu Inchon 407-753 Korea
young7@compedu.inue.ac.kr {fish,jbpark}@eslab.inha.ac.kr

This paper is a study on the design and implementation of the cooperative monitoring system using a mobile agent for an educational portal site. Generally educational portal sites have many addresses of teacher's homepage related education. Therefore, portal site has a very difficult task with maintaining a consistent address of site as well as it is impossible that administration of portal examines all dead sites in searching education site and DB. In order to solve this problem, we designed and implemented a mutual cooperative monitoring system to filter off dead site using a mobile agent. This monitoring system applies to the Korean educational portal site (KEPS) for elementary students and teachers. For efficiency this system, we made an experiment that compared a cooperative monitoring agent system with a stationary monitoring agent system.

Keyword: **Education Portal Site, Cooperative Monitoring System, And Mobile Agent**

1 Introduction

Today, the advent of the web that can easily be connected through the "Internet" is known to be an easy and popular method for teaching and learning. Web-based educational homepages are used in many computer assistance medias and also the numbers of educational sites are on the increase extremely.

An extremely increase in number of homepage raises a question whether a student can search appropriate homepage for learning. In case of finding educational contents using a general searching engines, the searched site can exist an irrelevant contents against a student's request. Moreover the result of searching content fell into learning confusion, because the contents are difficult to apply at learning intact.

In order to overcome this problem, an educational portal site was constructed to gather only educational homepages that had been made several times before. An advantage of educational portal site is that content is used correctly and rapidly in learning because searching site is well constructed. In addition student can easily get suitable contents. For gathering of an educational homepage, an educational portal system, called KEPS, was constructed by the EDUNET and Inchon National University of Education.

While walking past a type of the gathered homepage in KEPS, it can be seen as to make not by an expert institution or a special company but by a teacher and a private person. As a result, characteristic of the homepages have to be petty and is frequently updated. Because the educational homepage can disappear easily, portal site faces difficulty to maintain consistency of the site address. If a hyperlinked address of a portal site is not connected or the retrieval site is disappeared to user, then this portal site may bring discredit to student. In order to maintain consistency of portal, the administrator of portal site must validate all addresses of site. But this examination is impossible work that man completely manages and finds. Consequently, a monitoring of a site address for finding the dead site can be process by an intelligent agent instead of human.

A single agent needs comprehensive amount of time required for the monitoring of a portal site. If a single agent examines extremely a many site addresses, the monitoring work may be inefficient. Because a mobile agent is possible with decentralization and a parallel processing, the monitoring works using a mobile agent can be process effectively [5].

Accordingly, this study designed and implemented a mutual cooperative monitoring system to filter off dead site using a mobile agent. In the following section, the mobile agent and monitoring scheme will be surveyed and the overview of the structure of monitoring agent will be designed. And the next section will be focused on implementation and experimentation of monitoring agent system. Finally the conclusion and future works will be described.

2 Mobile Agent and Cooperative Monitoring

The agent is a program with intelligent characteristics to help the users with the use of computers and take the user's place. The intelligent agent perceives any dynamic stimulation or condition and interprets the data collected for a solution to the problem and exercises reasoning for a final decision. It also acts to change the conditions within its environment in order to perform assigned duties. It has autonomy, social ability, reactivity, pro-activeness and a cooperative relationship, learning, mobility, and so on [9].

Generally an agent divides a kind of two by the mobility, a stationary agent to be executed roles in single system, while the mobile agent is executed at various systems after moving through the networks. An execution example of the mobile agent is shown in figure 1 and the mobile agent based environment is viewed figure 2. The mobile agent server must be installed to act a mobile agent as figure 2.

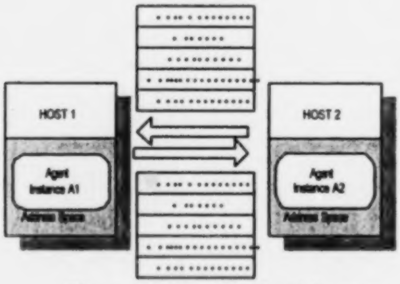

HOST 1
Agent
Instance A1
Address Space
HOST 2
Agent
Instance A2
Address Space

Figure 1. Execution of mobile agent

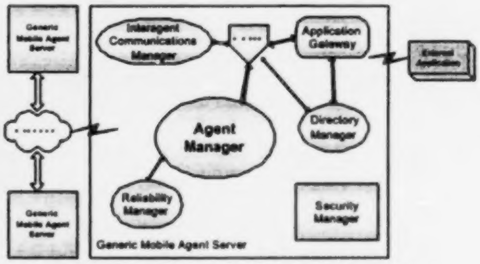

Generic Mobile Agent Server
Interagent Communications Manager
Application Gateway
External Application
Agent Manager
Directory Manager
Reliability Manager
Security Manager
Generic Mobile Agent Server
Generic Mobile Agent Server

Figure 2. Mobile agent based environment

The mobile agent has a specific characters listed below compared with a stationary agent [5][6].

- The mobile agent reduces the network load.
- The mobile agent overcomes network latency.
- The mobile agent encapsulates protocols.
- The mobile agent executes asynchronously and autonomously.
- The mobile agent adapts dynamically.
- The mobile agent is naturally heterogeneous.
- The mobile agent is robust and fault-tolerant.

In the information retrieval, a monitoring work ascertains a state of gathering sites for the maintenance of data consistency. Generally, because the information of the web is changed frequently, a monitoring job by human is an impossible or inefficient work. This monitoring job can be processed by intelligent a computer program instead of a human. Such a program is called the web robot or an intelligent agent system [10][11].

In case of examining many sites in the monitoring work, if a single agent of the only server processes monitoring work, then the monitoring work may be needed long time and overloading of a monitoring server. The mobile agent has made possible cooperative and speedy monitoring job from distribution and parallel processing [8][11].

3 Cooperative Monitoring System

3.1 Overview of System

BEST COPY AVAILABLE

Overview of the KEPS system, including the temporary monitoring agent system is shown figure 3.

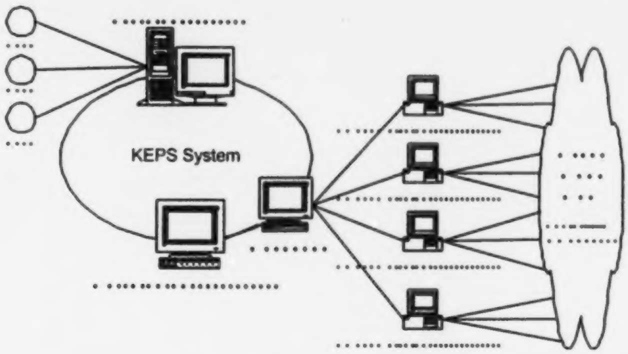


Figure 3. Overview of system

The portal system is consisted of four parts. There are the portal web server (PWS) and the monitoring agent server (MAS), the temporary monitoring server (TMS), a mediator. For using educational portal service, user must be connected with the Portal web server. Gathered address of an educational homepage is supported searching service of an education contents to user through the Portal web server. The Portal web server has searching engine, site DB and a query processor. The monitoring agent server has a stationary monitoring agent and a cooperative mobile agent, error DB, a mobile agent server. Also the monitoring agent server performs works as a creation and an allocation, a control, a gathering of the monitoring mobile agent. For the mobile agent perform it's task fully, each server is installed the mobile agent server necessarily.

The temporary monitoring servers are in existence out the KEPS system. In order to process a fast monitoring work, the TMS have function of distributed and parallel processing. The number of TMS is not fixed but dynamic by amount of monitoring job. Furthermore the TMS is used in temporary palace which mobile agent examines each a state of the registered site. At ordinary times, the TMS is not used usually for examining a state of the registered site. However the TMS can be only used when is requested by the mediator agent server.

The mediator is situated between the monitoring agent server and TMS, and acts as the role of mediation with the mobile agent and servers. All agents and agent servers must be registered in the mediator.

3.2 Design of KEPS System and Cooperative Work

The structure of the KEPS System is detail shown figure 4. The portal web server is consisted of searching engine and query processor, is shared the gathering DB of portal site. The searching engine provides searching service about education content and the query processor is shown the result searching at DB. The monitoring agent server is consisted of inference engine and agent manager, error DB. The monitoring system in monitoring agent server has a stationary agent and a mobile agent for distribution and parallel working. A stationary agent examines the state of gathering site and the confirmation of HTML documents through HTTP connection. After a failure sites are saved at temporary error DB, these will be deleted from site DB of portal web server. A permanent deletion of fail sites is executed by inference engine of the monitoring agent server.

When a monitoring agent server is overloaded or the stationary monitoring agent has difficulty processed by examination with many site, the monitoring agent server requests to the mediator about information of the registered TMS. If the number of the TMS is lacking, the monitoring agent server waits until the TMS becomes sufficient. Having sufficient number of the TMS, the mobile agent is created to divide as a suitable size of address by inference engine. And then the mobile agent has been created by a monitoring agent server, will be cloned with suitable number. Each mobile agent is allocated a monitoring work and will be dispatched to the TMS through ATP connection. The mediator agent can grasp each work states of an agent by using the agent finder.

Each agent is moved to temporary monitoring server and examines the allocated addresses of sites through HTTP. When a mobile agent is finished all checking of sites, it sends to the monitoring agent server with the result of observation. If the job of the mobile agent is occurred some problem, monitoring agent server creates a new mobile agent and re-dispatches to the TMS. All results gathers, result of examination saves at site DB and error DB. Finally, dispatching the agents retracted by the monitoring agent.

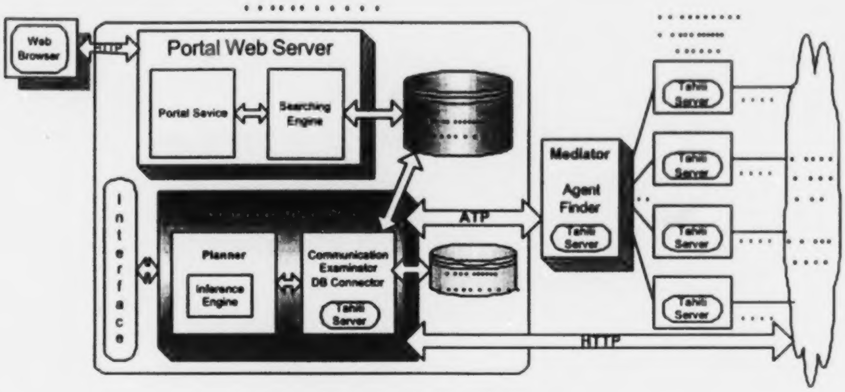

Web Browser
HTTP
Portal Web Server
Portal Sevice
Searching Engine
Interface
Planner
Inference Engine
Communication Examinator DB Connector
Tahiti Server
ATP
Mediator
Agent Finder
Tahiti Server
Tahiti Server
Tahiti Server
Tahiti Server
Tahiti Server
HTTP

Figure 4. Structure of the KEPS system

The processing algorithm of execution about monitoring working is shown figure 5. The job of monitoring using the mobile agent has advantages that prevent an overloading of a single server and lessen monitoring time by distribution and parallel processing. Because agents are not used stationary server but are dynamically used in other servers, all servers performed share resources of monitoring system. Accordingly, each agent can do cooperative parallel processing using autonomous and society properties of agent.

4 Implementation and Experiment

4.1 Implementation and Application of System

The monitoring agent system proposed in this study was implemented two types. The stationary monitoring agent was implemented by using VC++ and CLIPS. Also the mobile monitoring agent system proposed in this study was implemented using JAVA based Aglet API and JESS. Aglet is the java class library for that can easily design and implement all the properties of the mobile agent. Moreover the Aglet provides with the Tahiti server and Agent finder for helping research of users.

The stationary monitoring agent interacts with the mobile agent of Tahiti server based environment. Inference engine of the stationary monitoring agent was used the CLIPS dynamic linked library and the mobile monitoring agent system was used the JESS class library. The CLIPS and JESS are rule based inference engine and was used to infer planning and allocation of the mobile agent. SQL was used for the gathering DB of portal site. ODBC and JDBC were used to connect the monitoring agent system and the gathering DB of site.

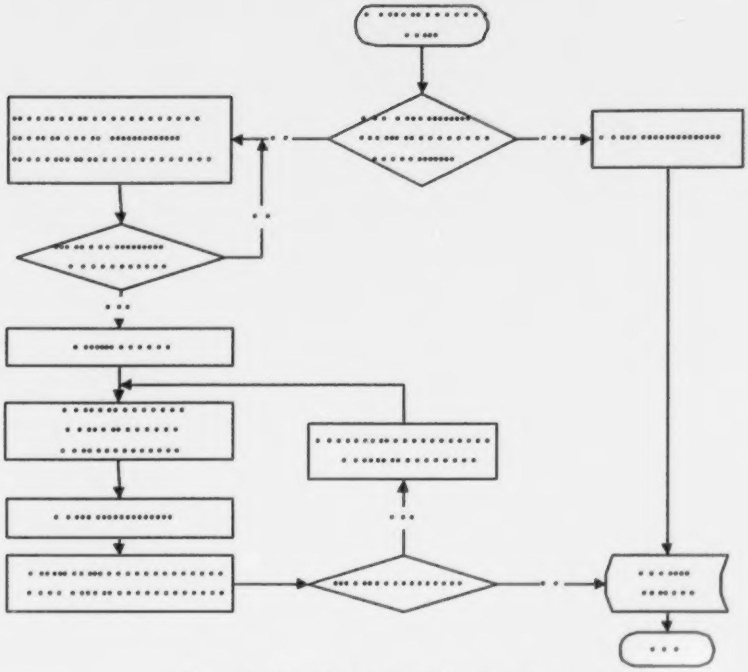


Figure 5. Algorithm of monitoring procedure

Figure 6 below is image of the interface of the stationary monitoring agent by making VC++. Figure is shown that the single monitoring agent is examining each site. The stationary monitoring agent was consisted of three parts mainly. The left screen of figure is represented list that the agent will examine site of DB. Also the center of screen is viewed results of a successful site and the right screen is represented results of a failure site.

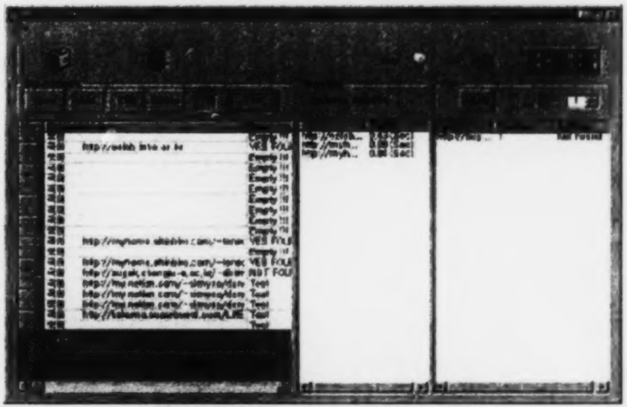


Figure 6. Stationary monitoring agent

Figure 7 is shown screen that the mobile monitoring agent is examining each site with distribution and parallel processing. If the numbers of sites are many in existence, the stationary monitoring agent executes the mobile agents to interact with the Tahiti server as followed image. Above window of figure is represented the stationary monitoring agent. Black screen below is viewed that mobile agent sever is executed by the stationary monitoring agent. Small screen below is shown the Aglet viewer. The Aglet viewer perform an important role as a creation, dialog, dispose, cloning, dispatching, retracting of a mobile agent.

BEST COPY AVAILABLE

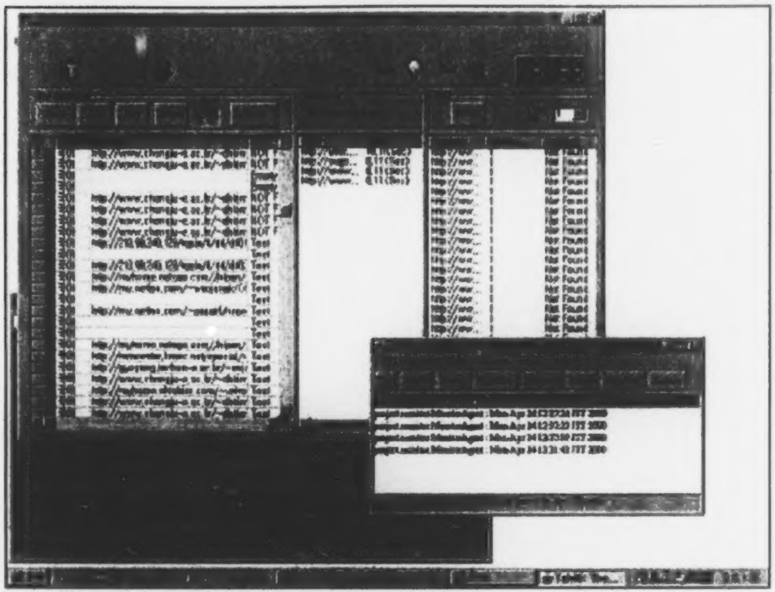


Figure 7. Interaction between stationary monitoring agent and Tahiti server

In order to use the implemented monitoring system in this study, we applied at the educational portal system and the KEPS system in the EDUNET server. Figure 8 is shown the searching screen of the web browser using KEPS system. This portal site in the EDUNET was constructed for the Korean elementary student and teacher. Also this site contains all contents about the curriculum of the Korean elementary school.

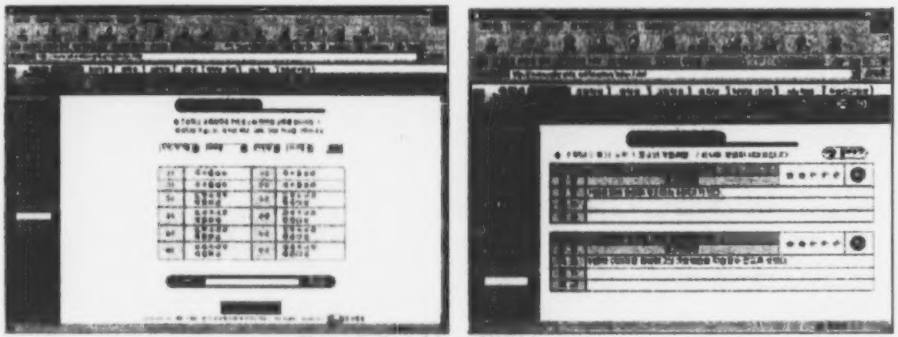


Figure 8. Searching of KEPS system

4.2 Experimental Results

For examining the efficiency of the cooperative monitoring system using the mobile agent, we compared and evaluated a monitoring time of each agent system. A comparative and estimative items listed below are as followed.

- Comparative item
  - *The single stationary monitoring agent vs. the cooperative monitoring agents.*
- Estimative items
  - *The monitoring time of the single monitoring agent*
  - *The monitoring time of the cooperative monitoring agents(3)*
  - *The monitoring time of the cooperative monitoring agents(7)*
  - *The number of sites: 10,30,50,70,90,110,130,150,170,190 ..etc.*

BEST COPY AVAILABLE

The experiment measures examination time of sites using a comparative and estimative items above. The estimative result is shown Table 1 and is represented figure 9 with form of graph. The horizontal axis of graph is represented the number of site and the vertical axis of graph is represented monitoring time of each agent.

In case of the number of an examine site is small, the result of experiment is viewed that the single stationary agent is faster speed of examination than the mobile monitoring agent. Also, when mobile agent is dispatched to three servers, speed of examination is faster than is dispatched to seven servers. The reason is caused by overtime occurred because the many mobile agents are created, allocated, gathered.

However, the more the number of site increases, the faster the mobile monitoring agent gets speed of checking than the single stationary agent. In particular, when the cooperative monitoring system using many agents, experimental result is shown that a speed of examination is very fast. If a single stationary agent processes very many sites, the result of execution can be useless though the result is very accurate.

Consequently, the cooperative monitoring agent can become higher execution speed by distributed and parallel processing and an overload of network by using a mobile agent can be decreased. If a server has an active environment of the mobile agent, the servers can be used with an active space of a searching agent and a monitoring agent.

Table 1. Result of monitoring time

Number of Agent Agent Type	10	30	50	70	90	110	130	150	170	190
Stationary Monitoring Agent	42	137	201	261	374	412	518	592	645	743
Mobile Monitoring Agent(3 Servers)	120	132	143	165	221	253	262	282	316	335
Mobile Monitoring Agent(7 Servers)	130	121	124	122	148	143	147	183	186	182

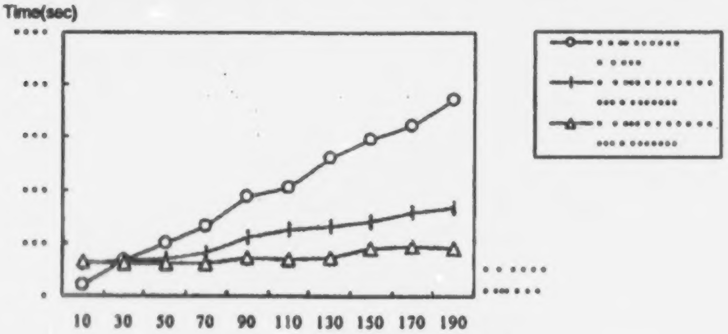


Figure 9. Graph of monitoring result

5 Conclusion and Future works

This study is on the efficiency of cooperative monitoring agent using mobile agent for educational portal site. The monitoring job has been getting difficulty processed by human. Thus, an intelligent agent can process the monitoring of the portal site instead of human. A monitoring work by using a single stationary agent needs long time for checking of many sites.

In order to overcome the problem in this study, the mobile agent is used in monitoring job. The monitoring job of educational portal site can be processed by collaborative method of decentralization and parallel using the mobile agent. The monitoring system was implemented by using the Aglet and Tahiti server. This system could execute cooperative monitoring job through an intelligent interaction between the stationary agent and a mobile agent. Also the KEPS system is possible with the mediation and the registration of agents by using the mediator agent between the monitoring server and the temporary agent sever.

BEST COPY AVAILABLE

The temporary agent sever is not fixed with the number but can be dynamically changed. Therefore all servers are by resources of monitoring job and each server can exe cute its role by inference.

More studies are required on research that constructs knowledge base for inference engine of the mobile agent. For effective portal site constructed, future work needs researches about not only intelligent monitoring but also intelligent searching and gathering of educational information. In order to interact between the mobile agents, we require research about KQML, language for sharing and exchange of knowledge between agent and agent.

References

[1] Akhil Sahai, Christine Morin INRIA-IRISA, • Mobile Agents for Enabling Mobile User Aware Applications• ;Just Research, 1998.

[2] Barbara Hayes-Roth. "An Architecture for adaptive intelligent agent systems", Artificial Intelligent, Vol 72, pp.329-365, 1995.

[3] Bryce L. Allen, Information Tasks: Toward a User-Centered Approach to Information Systems:, Academic Press, San Diego, CA, 1996.

[4] B.Venners,"Solve Real Problems with Aglets, a Type of Mobile Agent", Java World, www.javaworld.com/javaworld/jw-05-1997/jw-05-hood.html.

[5] Chang, D., Lange, D. "Mobile Agent: A new paradigm for distributed object compuing on the WWW. In Proceedings of the OOPSLA96 Workshop: Toward the Integration of WWW and Distributed Object Technology, ACM Press, N.Y., pp 25-32, 1996.

[6] Danny Lange and Mitsuru Oshima "Programming and Deploying Java Mobile Agents with Aglets", Addison-Wesley Longman, Mass., 1998.

[7] David Pallmann, "Programming Bots, Spiders, and Intelligent Agents in Microsoft Visual C++", Microsoft Press,1999.

[8] J.White, "Mobile Agents," in Software Agents, J. Bradshaw, ed., MIT Press, Cambridge, MA,1997.

[9] M. Wooldridge, M., Jennings, N. R., "Intelligent Agents: Theory and practice. The Knowledge Engineering Review, 10(2)", Springer-Verlag, pp 115-152, 1995.

[10] Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval", Addison-Wesley, 1999.

[11] R. Tolksdorf, "Intelligent Information Agent: On Coordinating Information Agents and Mobility", Springer-Verlag, pp 396-411,1998.

Development and Evaluation of Web-based In-Service Training System for Improving the ICT Leadership of Schoolteachers

Kanji AKAHORI*, Hidetsugu HORIGUCHI, Katsuaki SUZUKI*** and Masatoshi NAMBU******
**Tokyo Institute of Technology*
Graduate School of Decision Science and Technology, Dept. of Human System Science.
2-12-1, Ookayama, Meguro-ku, 152-8552, Tokyo,
Tel.+81-3-5734-3233, Fax +81-3-5734-2995, akahori@ak.cradle.titech.ac.jp
***National Institute of Educational Research,*
****Iwate Prefectures University, ****Jyoetu University of Education*

This paper describes an analysis of the effectiveness of an in-service training system developed by a project sponsored by the foundation of the Information-technology Promotion Agency, Japan (IPA). We developed and carried out a 10 days training course for 65 teachers in three different locations. The three main elements of this course were (1) training curriculum, (2) CD-ROM materials, and (3) Web-based support system. The participants of this course were hoping to become Information Technology (IT) leaders in their schools. An analysis was conducted to investigate the factors influencing the effectiveness of the training. Based on our analysis, we were able to draw the following conclusions: (1) Web-based training support system and CD-ROM materials were very effective to improve teachers' knowledge and skills, regardless of prior knowledge and skills (2) Traditional instructional style (i.e. one-way instructor-centered style) was generally an ineffective training method.(3) CD-ROM materials significantly enhanced the effectiveness of teachers' creating materials (such as a Web page), especially when the CD-ROM was used for self-study. These findings will be useful for educators and educational designers who plan and conduct in-service training programs.

Keywords: **Distance Education, Teacher Training System, Web-based Learning, Teacher Education, Training Program Assessment**

1 Introduction

The Japanese Ministry of Education decided to introduce the Internet to all Japanese schools (i.e. elementary to high schools) by 2001 to promote students' Information Communication Technology (ICT) literacy and the effective utilization of information tools to enhance subject-area learning. It has been reported that in order to realize information technology education, three major factors are crucial: Preparing sufficient hardware, providing excellent software, and promoting teacher's ICT literacy (refs. [1]). Several papers describe certain barriers for integrating ICT into curricula (ref. [9], [5]). The Ministry of Education in Japan introduced several projects aimed at promoting teacher training by removing these barriers. One of these projects was named "Project for development and evaluation of in-service training system for improving the ICT literacy of schoolteachers" sponsored by the Information-technology Promotion Agency foundation (IPA). This project was divided into two sub-projects, one to develop ICT leadership of schoolteachers, and another promote the training of ICT coordinators. This article examines the development of ICT leadership of schoolteachers, especially focusing on the evaluation of in-service training system.

The project consists of about forty members, joined by a variety of experts including engineers from computer software companies, ICT-experienced teachers, and university researchers. The project has conducted over one year starting in 1998, and included the following elements:

(1) Development of training curriculum and support system
(2) Implementation of the training according to the curriculum using the support system
(3) Analysis of effectiveness of the training system

2 Outline of in-service training system

The training system consists of major three components: (1) training curriculum, (2) CD-ROM materials and (3) Web-based support system.

2.1 Training curriculum

The guiding concept of the training curriculum is based on a constructivist approach (refs. [11]), and computer-mediated, problem-based training such as the learning from doing complex, challenging, and authentic problem through collaboration and communication (refs. [8]). The curriculum was designed to achieve the following goals:

(1) To train ICT leaders to play the central role in promoting classroom teachers' ICT literacy in each school.
(2) To attach greater importance to practical skills (rather than computer operation skills) by using ICT tools in actual classes (refs. [5], [14]).
(3) To improve basic skills of networking such as connecting to the Internet and configuring the school's LAN.
(4) To develop consultation skills for the leader to provide advise classroom teachers.
(5) To provide a computer-mediated learning-support system for sharing knowledge dynamically.

2.2 Development of CD-ROM materials

CD-ROM materials were developed in cooperation with a computer software engineer, an expert teacher, and university researchers according to the training curriculum. Many resources related to the training course, including teachers' case studies and video of actual classes using ICT tools which were recorded onto CD-ROM and used for instructor's presentation and participant's self-learning (refs. [6]). Figure 1 shows an example of an interview scene of expert teachers on CD-ROM materials, five disks in total.

2.3 Web-based support system

Fig.2 shows the configuration of a web-based support system for training. This support system consists of many modules such as database references, collaboration support, registration, and management of bulletin boards, checking items and participant's response in order to realize sharing discussion, collaborative group-based works and participants' reflection on each other's work (refs. [3], [12]). Fig.3 shows an example of a bulletin board in the system where participants can submit and share their opinions.

3 Design of system evaluation

The training program was conducted in three different locations. Each program ran for a period of 10 days, and a total of 65 teachers participated. These participants were identified as candidates to become school ICT leaders. The program for the training course, which consists of 12 topics, is shown in table.1.

Evaluation plays a critical role in the improvement of a training system. Despite the importance of evaluation, little research exists to analyze the factors contributing to the effectiveness of the training system (refs. [7], [10], [13]). In order to obtain findings helpful to the design the training program, we carried out an evaluation according to the following scheme. Checking was done at pre- and post- training, and all training scenes (such as participants' talk, activities, collaborative work and instructors' presentations) were videotaped for measuring activities' time and conducting qualitative analysis.

We introduced a total 106 items organized into 12 topic areas. Participants were required to respond to these 106 items before taking the course (pre-check), again just after taking the course (post-check), and one last time after the training was finished (after check). We compared differences among scores of pre-, post-, and after check scores in the course. In order to analyze the factors influencing differences of pre- and post-scores, we carried out the regression analysis shown in a later section.

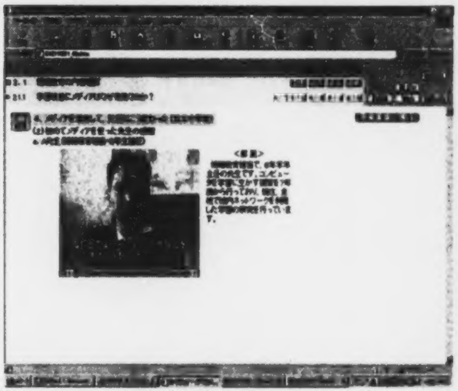


Figure 1. An example of motion picture of CD-ROM material: Interview Scene of expert teachers

Figure 3. An example of a bulletin board in web-based support system

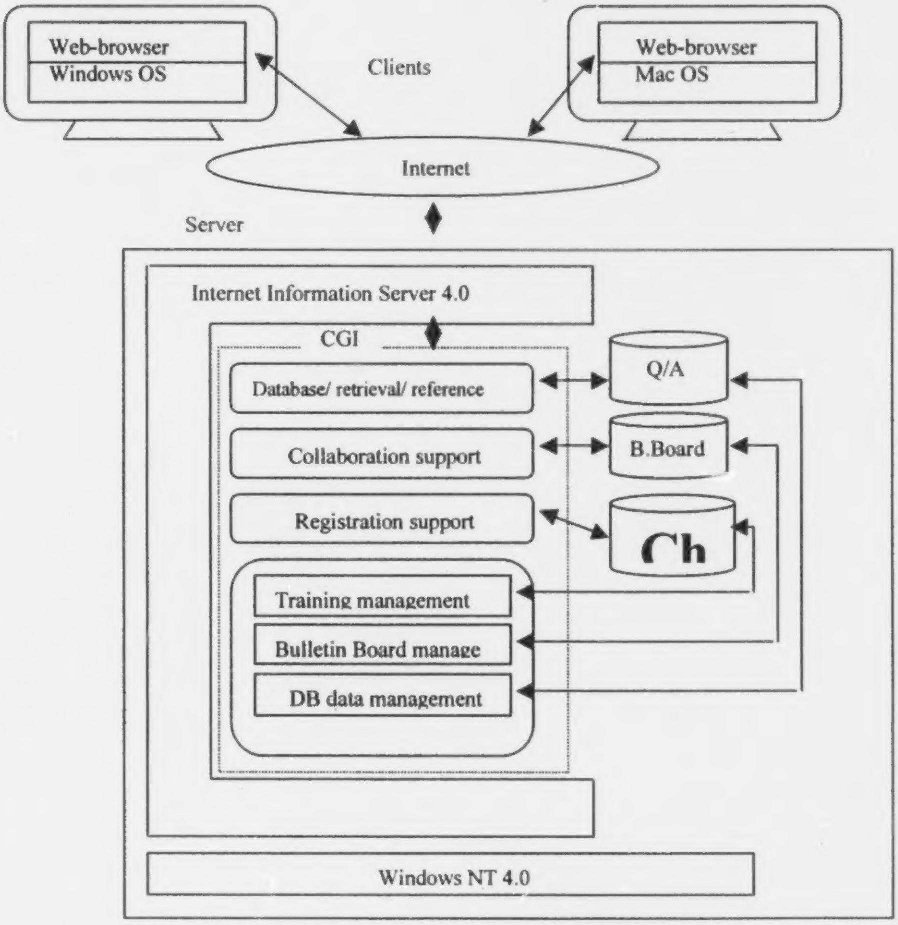

Web-browser
Windows OS
Clients
Web-browser
Mac OS
Internet
Server
Internet Information Server 4.0
CGI
Database/ retrieval/ reference
Collaboration support
Registration support
Training management
Bulletin Board manage
DB data management
Q/A
B.Board
Ch
Windows NT 4.0

Figure.2. Configuration of web-based support system

BEST COPY AVAILABLE

	In the morning		After noon		Assignment
Date	9:00 10:30	10:40 12:00	13:10 14:40	14:50 16:20	16:30 17:30
1st	Orientation Opening ceremony	Present situation and some problems in ICT education Ministry of Education Lecture	Direction of information society Lecture/Discussion	Fundamental technology supporting ICT education Lecture& discussion	
2nd	Contents and methods on ICT education Lecture and discussion		Curriculum development of ICT education Presentation and group work		Homework to develop school curriculum
3rd	To continue developing curriculum for each school	Participants' Presentation of each curriculum Discussion	Technical Foundation on OS, Multimedia and network Demonstration and lecture		Homework for topics
4th	Foundation of network focusing on LAN in campus, design of configuration of LAN, and management of network system Demonstration and lecture		Information ethics and privacy protection Lecture and discussion	Producing homepage Demonstration and individual work	Homework as homepage producing
5th	Presentation of produced homepage Discussion How to make materials		ICT utilization to subject learning and the role of computer and the Internet Lecture and discussion		Homework for topics
6th	How to develop a lesson plan and how to make materials using computer, hypertext and internet Presentation and group work				Homework for materials production
7th	Continuing to materials production Group work		Presentation of produced materials Discussion	Collaborative learning Lecture/discussion	Homework for checking consultation
8th	How to develop consultation skills concerning to ICT education Discussion and group work		Practice of consultation Discussion and group work		Homework for practice
9th	How to promote and manage in-service training at each school Presentation and discussion		Practice to make training plan at each school Group work and discussion		
10th	Presentation of training plan Discussion	Issues on management of training in a school Discussion	Closing ceremony		

Table 1. The training program for a 10 days training course

4 Results of differences among pre, post and after taking the course

The rating system consisted of four levels: 4 (good understanding), 3 (some understanding), 2 (little understanding), and 1 (no understanding at all). The maximum score is 424 (calculated by 4 times 106), and the minimum score is 106. Figure 4 shows the change of total scores with post- and after check sorted on pre-check scores. This figure shows that the scores with post- and after check are almost independent on pre-check scores, which means the training program was effective regardless of participants' prior knowledge and skills.

The figure also shows three regions which are the pre-achieved region before training, the achieved region by the training. and the unachieved region in spite of the training. Therefore, we can evaluate the area size of the achieved region by the training as the training effectiveness. In roughly estimation, it was as desirable as expected.

4.1. Analysis of factors affecting the training effectiveness

In order to pick up the factors affecting the training effectiveness, we made the following assumptions.

Assumption 1. The in-service training system will be effective to all participants with various prior ICT knowledge and skills, as anticipated from the previous section. .

Assumption 2. The Web-based training support system and CD-ROM materials will work well with comparison to the traditional training system such as lecture-based instructional style.

The model for testing these assumptions is as following.

Post-check score ← pre-check score + Web-based support system
+ CD-ROM materials + Instructional style

Where, pre-check score represents participants' prior knowledge and skills, post-check score represents participants' knowledge and skills achieved by the training, and instructional style shows instructor's presentation, participants' individual learning, group works and so on. This model is based on the relation that the post-check score, it is called as a dependent variable, is influenced by other independent variables such as pre-check score, Web-based support system, CD-ROM materials and instructional style. Here, we call the above independent variables as factors affecting the training effectiveness

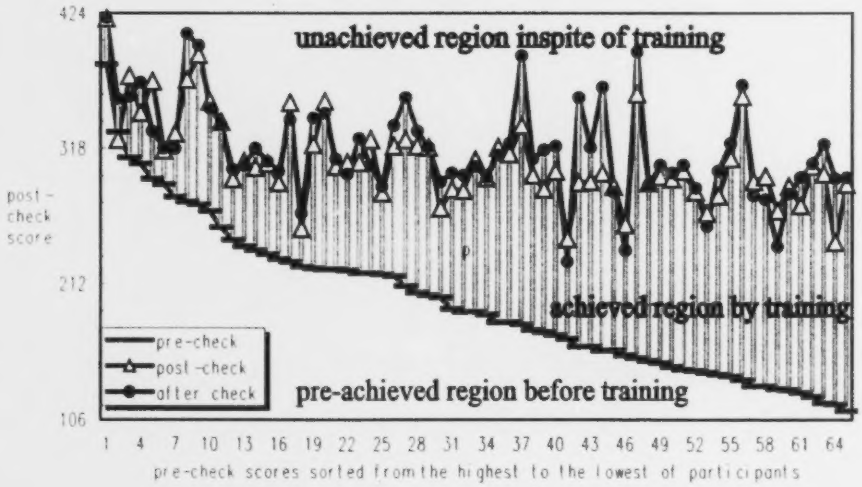


Figure 4. Dependence of post- and after check scores sorted by pre-check scores

The regression analysis should be suitable for evaluating the factor's size. The factor's size can be obtained by calculating the regression coefficients of each independent variable in the above regression equation. Here, we will adopt the time spent during the training course as a value of independent variables except pre-check score. This means that the factor with more spent time contributes to the training effectiveness more than the less spent time. We can estimate the size of regression coefficients as the affecting size of factors. Time spent in each factor was measured using videotapes recording all training course. A part of data is shown in table 2. In the table, topics number shows topics in the training course, 12 in total, factors show lecture, presentation, group work Web-based support, CD-ROM for use and so on, and numerical data in the cell show the spent time in each factor and each topics with the unit minutes except scores.

Table 3 summarized the result, data of the regression coefficients' size, calculated by regression analysis and the result is shown in figure 5 as a visual graph

Topics No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Check items counts	10	5	4	15	18	8	8	5	4	9	12	8	106
Lecture	58	76	73	58	163	30	87	28	38	72	13	22	718
Presentation	80	0	62	22	40	10	55	83	0	159	112	35	658
Group work	0	0	91	93	93	0	55	0	0	0	173	0	505
Individual learning	0	25	0	32	73	0	60	80	0	35	0	0	305
Web-based support	10	25	22	9	10	18	10	9	43	43	10	5	214
CD-ROM for individual	32	30	15	0	0	0	12	30	10	0	0	93	222
CD-ROM for group work	0	0	14	0	0	0	0	0	0	55	0	0	69
CD-ROM for presentation	8	13	3	119	5	74	41	12	27	9	28	0	339
Pre-check score	1.84	2.21	1.80	1.69	1.81	1.42	1.81	1.63	1.43	2.24	1.89	2.19	
Post-check score	2.69	3.01	2.79	2.79	2.94	2.91	2.85	3.03	3.16	2.89	3.02	2.91	

Table 2. A part of data table showing the spent time for elementary teachers
Time unit: minutes, pre- and post- scores: average score

N (total counts of items)=36 (=12 factors times 3 locations)

□(decision coefficient)□ **0.713 * (p<0.05)**

Dependent variable□scores of post-check

Factors (Independent variables)□

	factors	sub factors	regression coefficient
(1)	pre-skills of teachers	pre-check score	**0.010**
(2)	training style	lecture	**0.332 + (p<0.10)**
		presentation	**□0.220**
		group work	**0.180**
		individual work	**0.364 + (p<0.10)**
(3)	supporting system	web-based system	**0.589 ** (p<0.01)**
(4)	CD-ROM materials	for self learning	**0.310**
		for group work	**0.068**
		for presentation	**0.010**
(5)	school class	elementary	**0.360 + (p<0.10)**
		junior high school	**0.065**

Table 3. Result of regression analysis: coefficient's size of each variable

From table 3 and figure 5, we could find the following results.

(1) The biggest influencing factor was the Web-based support system, which was statistically significant within 1 percent level.

(2) More spent time using CD-ROM for self-learning contributed to higher scores in the post-check. This means that the CD-ROM is more effective when used for self-study than other uses such as group work and instructor's presentation.

(3) More spent time in instructor's presentation was less effective to the scores of post-check, which was statistically significant. This means that a traditional teaching style, such as one way directed lecture-based style, is ineffective to the training.

(4) Differences were found between teachers of elementary and junior high schools.

(5) Scores of post-check were almost independent to scores of pre-check. This means that the training system will work effectively regardless of quantity or quality of a teacher's prior knowledge and skills as expected in the previous section.

From the above results, we can conclude that the first and second assumptions substantiated.

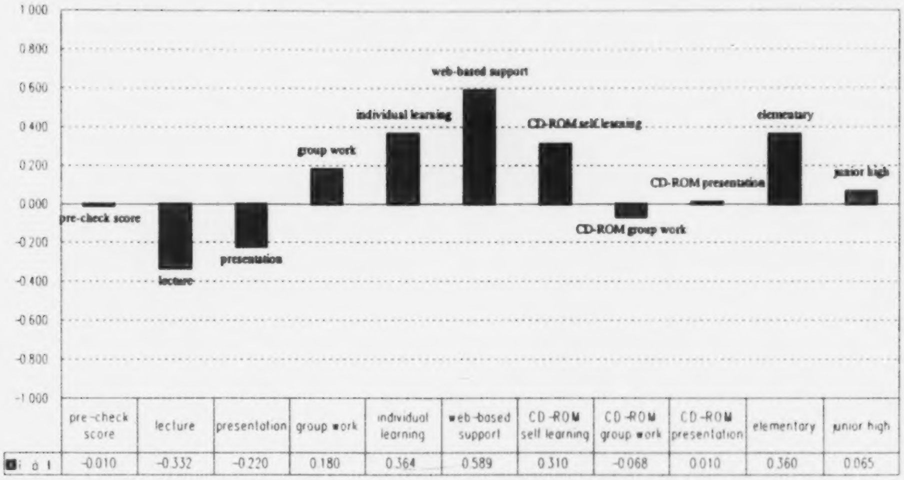


Figure 5. Comparison of each factor's size

4.2. Analysis of factors affecting on the works produced by participants

In the training course, participants were assigned to produce works such as homepage, a lesson plan using CD-ROM, and so on. Instructors rate the produced works with four grades from the points of check items' view. The regression analysis was done using the similar method as the previous section. The result is shown in table 4,

N (total counts of items)=21 (=7 produced works times 3 locations)
□(decision coefficient)□**0.764 ** (p<0.01)**
Dependent variable□scores of produced works rated by instructors
Independent variable□

	factors	sub factors	regression coefficient
(4)	CD-ROM materials	for self learning	**0.522 ** (p<0.01)**
		for presentation	□**0.574 ** (p<0.01)**

Table 4. Result of regression analysis on produced works

We could find only the factor of CD-ROM materials as statistically significant, shown in table 4. From this result, we could find that only using CD-ROM materials for self-learning works effectively. In contract, the use of CD-ROM materials for instructor's presentation was relatively ineffective. It can be interpreted that one way directed instructional style was also ineffective to work-production, which was the same finding as shown in the previous section.

5 Conclusions

The conclusion is summarized as the following:

(1) Web-based training support system and CR-ROM materials were effective to improvement of teacher's knowledge and skills, regardless of quantities and qualities of prior knowledge and skills.
(2) Traditional training style, one-way directed and instructor-centered style, was ineffective to in-service training.
(3) Using CD-ROM materials for self-learning enhanced the quality of teachers productions.

From the above conclusions, we can give some useful suggestions to educators and administrators who plan to conduct in-service training courses. The important points are:

BEST COPY AVAILABLE

(1) Modify the training approach from a traditional teacher-centered to a participant-centered style (refs. [2]),
(2) To introduce rich materials for self-learning or group works (refs [4]),
(3) To introduce Web-based support system,
(4) To promote opportunities for exchanging teachers' knowledge and skills, especially rich-experienced practical know-how.

Suggestions (3) and (4) are very important because teachers can share their know-how with others, which works well when conducting real lessons in schools (refs. [9]). Web-based support system enables teachers to share their know-how and knowledge anytime, anywhere, and with anyone. Moreover, CD-ROM materials also can be used at anytime, anywhere, and by anyone. Therefore, it is important to provide rich self-learning resources that contain expert teachers' case studies and a support system that enables the sharing of dynamic, experience-based knowledge, and communication. Such resources can truly be called integrated training environments.

Acknowledgements

The authors would like to thank Ms. M. Suzuki, Fujitsu Learning Media Co., for her great assistance, and also Dr. D. J. Scott and Dr. M. Yanagisawa for their cooperation. We would also like to express our appreciation to the following people who assisted with this project: Mr. T. Maesako, Mr. K. Hatano, Mr. T. Horita, Mr. T. Nakagawa, Mr. T. Sanada, Mr. K. Nagashima, Mr. M. Suzuki, Mr. J. Tamura, Mr. K. Nakagawa, Mr. K. Tanaka, Mr. Y. Mohri, Mr. M. Maeda, Mr. M. Ichikawa, and Mr. M, Itoh.

References

[1] Akahori K., "Effectiveness and some problems of the Internet: Utilization to education from overview of school practice research in Japan", proc. of SITE (Society fro Information Technology & Teacher Education), 98 International Conf. in Washington, DC, 1157-1156,1998
[2] Collins M., "Comparing Web, Correspondence and Lecture versions of a second-year non-major Biology course", British J. of Educ. Technol. Vol.31, No.1, 21-27, 2000
[3] Collis B., "Designing for differences: cultural issues in the design of WWW-based course-support sites", British J. of Educ. Technol. Vol.30, No.3, 201-215, 1999
[4] Dillon P., Tearle P., Hudson A., "The Images for Teaching Education Project: developing multimedia resources within an integrative framework", British J. of Educ. Technol. Vol.30, No.4, 359-367, 1999
[5] Ertmer P. A., "Addressing First- and Second-Order Barriers to Change; Strategies for Technology Integration", Educational R & D, Vol.47, No.4, pp.47-61, 1999
[6] Jonassen, D., Rohrer-Murphy, L., "Activity Theory as a Framework for Designing Constructivist Learning Environments", Educational R & D, Vol.47, No.1, pp.61-79, 1999
[7] Kumar K.L., "Assessment of the Effectiveness of a Short Course via Internet", Educational Technology Research (in Japan), Vol.22, pp.27-33, 1999
[8] Laffey J., Tupper T., Musser D., Wedman J., "A Computer-Mediated Support System for Project-Based Learning", Educational R & D, Vol.46, No.1, pp.73-86, 1998
[9] Lawson T., Comber C., "Superhighways Technology: personnel factors leading to successful integration of information and communications technology in schools and colleges", J. of Information Technol. for Teacher Educ. Vol.8, No.1, 41-53,1999
[10] Ravitz J., " Evaluating Learning Networks: A Special Challenge for Web-based Instruction", in "Web-based Instruction" (Editor Khan B.H.) Educational Technology Publications, New Jersey, 361-368, 1997
[11] Reeves, T.C., Reeves, P.M. " Effective Dimensions of Interactive Learning on the World Wide Web", in "Web-based Instruction" (Editor Khan B.H.) Educational Technology Publications, New Jersey, 59-66, 1997
[12] Sannomiya, M., Kawaguchi A., "Cognitive Characteristics of Face to Face and Computer Mediated Communication in group Discussion: An Examination from Three Dimensions", Educational Technology Research (in Japan), Vol.22, pp.19-25, 1999
[13] Tessmer M., McCann D., Ludvigsen M., "Reassessing Training Programs: A Model for Identifying Training Excesses and Deficiencies", Educational R & D, Vol.47, No.2, pp.86-99, 1999
[14] Willis J., Thompson A., Sadera W., "Research on Technology and Teacher Education: Current Status and Future Directions", Educational R & D, Vol.47, No.4, pp.29-45, 1999

Development of a LAN-based Formative Evaluation Module as an Instructional Management System

Youngcook Jun and Wangryang We
Sunchon National University, Department of Computer Education
315 Maegok-dong Sunchon city, Chonnam, Korea, 540-742
{ycjun, wrwe}@rise.sunchon.ac.kr
Ph) +82-61-750-3341

This paper describes a LAN-based module program for formative evaluation during classroom teaching. Within one-hour classroom instruction, teachers can hardly assess what students significantly understand during history instruction. With this system, teachers are apt to create, modify, retrieve and manage formative evaluation processes based on a database. In addition, the teachers organize test items and other instructional materials in elaborated sequences relevant to their teaching plans. Our system consists of an instructional management tool and a module-based formative evaluation system. Our system is implemented with Visual Basic 6.0, Access DB and Crystal Reports 5.0. The final part of this paper presents how to enhance system based on the Bayesian inference system.

Keywords: **formative evaluation, knowledge diagnosis, instructional management.**

1 Introduction

School teachers are either implicitly or explicitly affected by the use of computer in classrooms. They tend to consider utilizing the computing power for their instructional improvement. One of the most prominent purposes for teachers to adopt the computer is regarded as Computer-Managed Instruction (CMI). How to manage instruction and learning in real classrooms turns out to be a very practical problem for teachers [2].

The survey result conducted by Lee, et al. [4] indicates that over 60% of the participants responded that they prefer using one computer per each person when software is applied to classroom instruction. Even though web technology has been dominated under the name of WBI (Web-based Instruction), our system is designed on the LAN environment due to heavy network traffic and rather a weak requirement for multimedia. We only focus how to enhance the teachers' capability to manage their instruction by adding formative evaluation module into the existing instructional sequences similar to a web-based formative assessment program [1].

This paper describes LAN-based VisEval which is a module-based formative evaluation system. The VisEval was originally designed as a quiz-like testing tool that makes Korean teachers avoid difficulties in assessing teaching materials to students. With this system, teachers are apt to evaluate the students' understandings as a part of performance evaluation that is encouraged among most of the Korean teachers by the Ministry of Education. In addition, the VisEval helps teachers elaborate teaching sequences relevant to their teaching plans by simply adopting other teaching resources due to modularized design of VisEval.

2 Design and implementation of VisEval 1.0

The VisEval 1.0 is a prototype system that helps teachers easily check students' learning progresses. This prototype is aimed at playing the role of an evaluation aid for teachers who usually skip the evaluation procedure during classroom teaching. The teachers thus take advantages of using the VisEval by creating, classifying, retrieving and managing test items before instruction. The overall framework was implemented in Visual Basic 6.0 with Access DB for Windows environment.

Within the limited time for instruction, teachers are expected to motivate students' learning and control the overall pace of instruction. Without any tool, teachers can hardly try to evaluate quiz-like tests at the end of instruction with further statistical analysis as a part of performance evaluation. With VisEval, teachers can set up the test duration so that the main classroom teaching cannot be overloaded for both teacher and students.

Our system is based on Module program which means that the whole teaching sequence are divided into small parts so that the teacher can organize the necessary parts for lesson plans. The traditional CAI program, on the other hand, is regarded as system-driven program, which means that the whole instructional program consists of one system containing domain knowledge and control structures. Our system is thus treated as a component-like module-driven program.

2.1 Module for teachers

A module for teachers is designed in the following ways: it is easy for teachers to reorganize test items and to manage evaluation procedures. The other important factor is associated with the way feedback is provided. Our system only provides immediate feedback only when the active engagement of the user is assured. Once the feedback is issued, the user is not allowed to solve similar problems but to receive guided instruction from the system with the treatment of the whole test items again. The user is only allowed to solve multiple choice items at a time. According to the result, the user is expected to repeat the test items in a linear fashion since the teacher only provides 10 minutes or so for students to transfer acquired knowledge items. The table 1 shows the main functions of instructional module of VisEval.

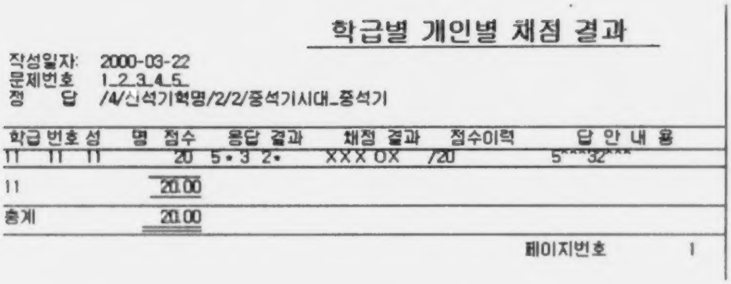
Table 1. Functions implemented in the module for teachers

Function name	Content
Item manger	Generation, modification, deletion of item DB, conversion of DB items into texts
Responses analyzer	Item response analyzer, Scoring functions
Simulation for students	Student' s trial for simulating
Other tools	Distribution of test files on LAN, collection of the test results, sharing of test files in different formats

2.2 Module for students

Once the module for teachers is ready to go students are expected to login the system. The immediate transaction of the test items enables the students to assess their own understandings of the learning materials. Without the corrective feedback, each student is allowed to follow his/her own guided instructional module provided by the system. Different formats of the test items are available with special characters such as mathematical symbols implemented by RTF (Rich Text Format). After the evaluation procedure, the transaction of the test results to the teacher' s computer is finished via LAN. The sample result of the students' assessment for one class is shown in figure 1, being created from Crystal Reports for Visual Basic. The analysis of each test item for each class is processed from the module for teachers as depicted in figure 2.

As the module for students is designed to provide supplementary learning according to test results, the control flow for guided learning is implemented. This mechanism is up to present indexed by the teacher' s setting with a predetermined threshold. We are currently investigating much fine-grained knowledge diagnosis method such as knowledge-state inference system based on Bayesian inference network. The flow control for guided learning to date is coded using item-binary matrix relying on the teachers' previous teaching experiences. The future modification plan of our system is explained in the following section.



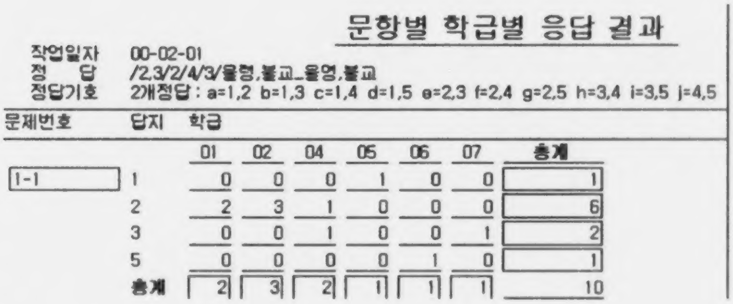
학급별 개인별 채점 결과

작성일자: 2000-03-22
문제번호 1_2_3_4_5_
정　답 /4/신석기혁명/2/2/중석기시대_중석기

학급	번호	성명	점수	응답 결과	채점 결과	점수이력	답안내용
11	11	11	20	5 • 3 2•	XXX OX	/20	5***32***
11			20.00				
총계			20.00				

페이지번호 1

Figure 1. Test results taken by individual student in each class



문항별 학급별 응답 결과

작업일자 00-02-01
정　답 /2,3/2/4/3/율령,불교_율영,불교
정답기호 2개정답 : a=1,2 b=1,3 c=1,4 d=1,5 e=2,3 f=2,4 g=2,5 h=3,4 i=3,5 j=4,5

문제번호	답지	학급 01	02	04	05	06	07	총계
1-1	1	0	0	0	1	0	0	1
	2	2	3	1	0	0	0	6
	3	0	0	1	0	0	1	2
	5	0	0	0	0	1	0	1
	총계	2	3	2	1	1	1	10

Figure 2. Item responses for students in each class

3 Conclusion

The features of the VisEval are, up to present, suited for Korean teachers' needs of easily evaluating high school history instruction in the computer rooms. Even though there are some limitations as being an automated instructional system, the VisEval will be enhanced further as the system evolves. One of the drawbacks in our system is the lack of guides and suggestions on how to accurately diagnose the students' knowledge states. The following future plan dictates possible enhancement of our system with two extra modules based on the previous research [3].

The first part is a module that draws knowledge inferences for a given student's problem states based on pre-built test item attributes. The second part decides which abilities of the student need complementary practices according to the diagnosis done by the inference system. This second module also provides students with adaptive ways of taking relevant problem items mapped from item-attribute matrix in the domain of middle school mathematics. As shown in Jun's research [2], all of these mechanisms are operated on the WWW environment via Common Gateway Interface (CGI).

We begin with carefully examining test items in terms of content domains and student abilities. By constructing an incidence matrix with content domains and student abilities, each test item can be mapped into a content-ability matrix. With this test item matrix, we proceed to building knowledge-state inference system based on Bayesian Inference Network algorithm[5].

For example, Certain contents and abilities can be pre-requisites of other concept, say node N1, which means students first need to understand the pre-requisites of the concept (N1). Priors of network nodes are empirically assigned according to teachers' teaching experiences. This big graph is then fed for computer programs that calculate Bayesian inference [4]. We tested Ergo [7] and Netica (http://www.norsys.com/home.html) for WWW environment. The result of processing such a Bayesian program updates probability distribution among nodes. Such posterior probabilities are discretely scaled so that VisEval can provide fine-grained guided learning materials to students.

In short, VisEval has several possibilities for future enhancement on WWW environment as an instructional management system for distance education as similarly reported in [1]. We furthermore pursue a fine-grained knowledge diagnosis capability with which the system intelligently guides students on their own paces outside classrooms. The use of Bayesian network algorithm seems promising for our future project. Error diagnosis system such as Rule Space model is another reference to encode test item attributes and projection space of multi-facets of knowledge items [9]. Even though the scope of our system is mainly focused on teachers' side in classroom teaching, the future version of VisEval can extend its capability of guiding students as an individualized learning management system.

References

[1] Han, B-R., Hong, J-Y., & Song, K-S. *Design and implementation of formative assessment program for distance computer education*. Journal of Korean Association of Computer Education, (2000).

[2] Jun, Y. *Web-based Computer-Managed Instruction for high school mathematics*. Paper presented at the ICMI-EAST Asia regional conference on mathematics education, Chungbuk, Korea., (1998).

[3] Jun, Y. & Kim, S-H. *Development of a Web-based Knowledge-State Inference System for Guiding Middle School Mathematics Learning*. Proceedings of ATCM ' 99, Guangjou, China, Dec., (1999).

[4] Lee, C-H., Shin, S-B., Yoo, I-H., & Lee, T-W. *Analysis of applications with educational software in Korea*. Proceedings of Korean Association of Computer Education, Jan., (2000).

[5] Mislevy, R. J. Probability-based inference in cognitive diagnosis. In P. Nichols, S. Chipman, & R. Brennan (Eds.), *Cognitively Diagnostic Assessment*. Hillsdale, NJ: Lawrence Erlbaum, (1995).

[6] Nichols, P. D., Chipman, S. F., & Brennan, R. L. *Cognitively diagnostic assessment*. Hillsdale, NJ: Erlbaum, (1995).

[7] Noetic Systems, Inc. ERGO [computer program]. Baltimore, MD: Author, (1991).

[8] Ritter, S. & Koedinger, K. An architecture for plug-in tutor agents. *Journal of Artificial Intelligence in Education, 7*(3/4), 315-34, (1996).

[9] Tatsuoka, K. K. Rule space: An approach for dealing with misconceptions based on item response theory. *Journal of Educational Measurement, 20*(4), 345-354, (1983).

Development of a Web System to Support Computer Exercises and its Operation

Hajime Kitakami, Sueda Takashi, Yasuma Mori and Susumu Kuroki
Faculty of Information Sciences Research, Hiroshima City University
3-4-1 Ozuka-Higashi, Asa-Minami-Ku, Hiroshima 731-3194, JAPAN
Tel: +81-(0)82-830-1587
Fax: +81-(0)82-830-1587
E-mail: kitakami@its.hiroshima-cu.ac.jp

This paper describes the development and operation of a Web-based system to support computer exercises used in a course on data structures and algorithms. To develop such a system, this paper proposes using the functions of a Web-based system to deal with a learner' s state transition model based on computer exercises. The Web system developed by us has useful functions, some of which are the management of participant registration, identification of learner's goals, web service of exercises, mutual interaction between participant and teacher, management of report submissions, and both provision and analysis of electronic questionnaires to participants. The use of this system resulted in students' heightened motivation to work, good communication between participants and teachers, and a reduced workload for teachers.

Keywords: **Web, Database, Exercise, Autonomous Learning, Domain Model, Communication, Questionnaire, Data Mining, Operation, Evaluation**

1 Introduction

The new curriculum of the Department of Intelligent Systems at Hiroshima City University has added computer exercises to subjects related to algorithms and programming, thus encouraging students, from freshmen to sophomores, to make the most of their ability for practical programming with representative algorithms. The curriculum offers two ongoing three-hour courses that include theory and practice.

This paper focuses on computer exercises for the course "Data Structures and Algorithms," which is a part of the core curriculum for sophomore students. The general objective of the course [1, 2] is to facilitate the transition from computer literacy to a professional level of information processing. Even though students have considerable knowledge of computer operations, they do not have perfect command of them Moreover, they do not have enough experience in basic programming techniques. In order for them to have command of the theory and the practice, we have developed many exercises to improve the management of participant registration and learner's goals, information about the exercises, mutual interaction between participants and teachers, management of report submissions, and collection of questionnaires, among others. However, a problem arises because the workload for both teacher and students increases in the process. To solve this problem, we have developed the necessary support Web system dealing with a learner's state transition model based on computer exercises. Moreover, we report the operational results obtained from real exercises.

2 Assessment of learners' situation before the training

The contents of the courses "Data Structures and Algorithms I" and "Data Structures and Algorithms II" were divided into two courses, each including both theory and practice, using C in the new curriculum The former includes major elements such as stack, queue, list, naive sort, recursive function, quick sort, tree structure, and binary sort in the second semester of the first year. The latter includes major elements [3, 4] such as complexity, file processing, linear search, binary search, hash, B-tree, pattern matching, graphical searches, Kruskal, and Dijkstra in the first semester of the second year. Since students can easily understand the content of many classes if they have attended C in an earlier semester, "Structured Programming" was also organized into two courses including both theory and practice using C in the first semester of the first year. This course includes major expressions such as if-, while-, and for-statements, array, data types, pointer, function, and structure in C. Moreover, the teaching of computer literacy includes major elements such as word processors (e.g., LaTex), programming tools (e.g., mule, e-macs), drawing tools (e.g., TGIF), the input tool for Japanese characters, electronic mail, X-window, and the shell command on UNIX, among others, in the same semester.

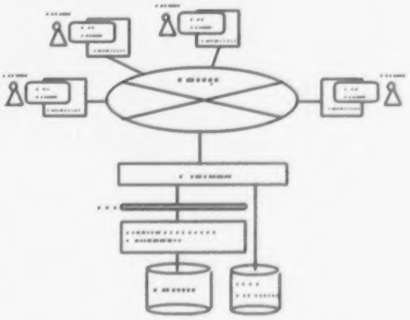


Figure 1. System Configuration

An evaluation of the learners' situation before starting the course "Data Structures and Algorithms II" that is the focus of this paper provided the following results:

(1) Students did not have much knowledge about algorithms and data structures with practical usage. They had learned simple and short programs but did not have much experience with longer programs. For example, they did not have experience in how to update longer programs by themselves.

(2) They did not have enough motivation for autonomous learning. They were less eager to learn than freshmen. For example, they did not consult textbooks or dictionaries on their own when they had trouble understanding an exercise.

(3) Twenty-five percent of the students did not understand the C language. Seventy-five percent of the students tended to forget the C language, since they had not had a chance to practice it for more than 2 months after the second semester of the first year.

(4) Many students did not have sufficient skills to attain perfect command of software tools such as TGIF or LaTex.

3 Conceptual view of the computer exercise

Figure 1 shows the system configuration to support the exercise. Since each learner does his exercises at a workstation connected to the Internet, he can access information managed by the Web server. The Web server stores the exercises as HTML documents. The application program located in the CGI (Common Gateway Interface) manages information related to his registration, personal goals, and questionnaires. The application program is implemented in Parl, Shell, and SQL. The information inputted by the Web browsers is stored in the database and used by the learners.

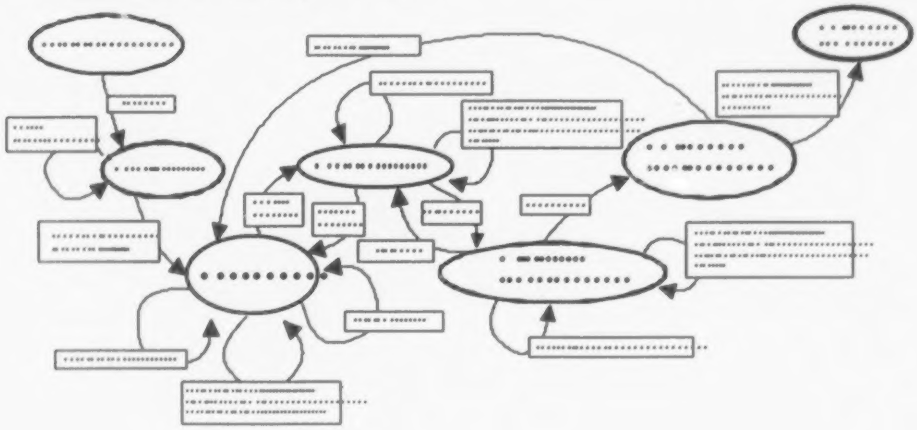


Figure 2. Computer Exercise Model

We tried to computerize human work as much as possible in the existing computer exercise. Notice of all 15 exercises included in the course was given on the Web page. We connected both basic programs and measurement data to the Web page for each exercise. Using a Web browser, both could be downloaded from the Web server to a student' s site. Before starting on the first exercise, students had to fill out an electronic registration form for the class using the Web browser. When a student inputted his school number, name, password, and e-mail (electronic mail) address in the registration form, the system issued him a registration number using e-mail and the Web page. If the student needed any information about the exercises after that, he could get it by inputting his registration number and password using the Web browser.

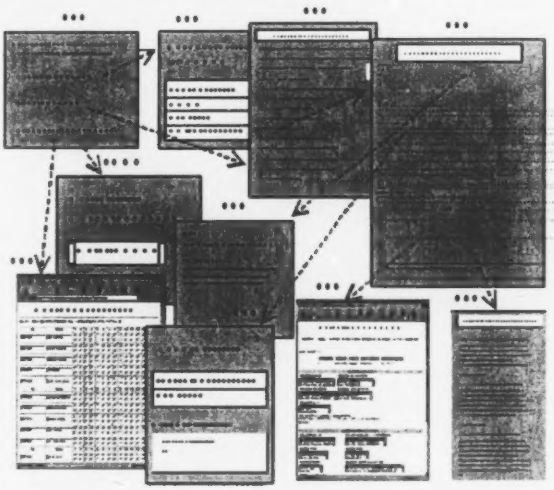


Figure 3. An Example of System Operation

Figure 2 represents the state transition for the computer exercise model. "Starting the Course," located at the left side of Figure 2, represents the state before starting the class. The student moves to the state of "Completing the Course" if he finishes all exercises successfully. If the student inputs personal data in the class registration form, the student moves to the state of "Class Participant." If the participant replies to the first questionnaire and inputs his personal goals for the exercise using the Web browser, he moves on to the state of "Exercising." At this stage, the learner is allowed to solve the exercise. If the learner inputs a question to the teacher on the Web page, he receives a reply from the teacher on the Web page. After finishing the exercise, the learner moves on to the state of "Making the Report" and can answer our questionnaire for the exercise as he finishes the exercise. If the learner submits his report to the teacher, he moves on to the state of "Waiting for the Evaluation." If the evaluation is poor, the teacher contacts the student, helps him, and asks him to re-submit the exercise. The Web system does not support their interaction in the situation, since we believe that face-to-face communication is preferable. This situation is different form Fujimoto's Classroom Management System [5]. After the learner reaches the state of "Completing the Submission," he will input his personal goals for the next exercise. After that, he will move to the state of " Exercising."

We place great importance on the use of educational methods [6, 7] including "Reading, Writing, and Using an Abacus" to achieve the goal of "autonomous learning and thinking." For students belonging to the categories (1)-(4) mentioned above, the computer exercise model includes the following educational methods. Students in (1) and (3) are asked to read longer programs downloaded from the Web server, write the respective flowchart, update the subparts, and measure their performance in the state of "Exercising" shown in Figure 2.

Students in (2) are asked to define their personal goals before reaching the state of "Exercising" and write a self-evaluation in the state of "Making the Report." In the state of "Exercising," students are given an ambiguous exercise to learn the value of searching for information. In this way, students are encouraged to develop their creativity skills. Moreover, students are strongly advised to use textbooks and dictionaries if they have unresolved questions. Students in (4) are strongly encouraged to use such tools as TGIF and LaTex when preparing a report that includes figures and text. We believe that longer programs particularly enhance their proficiency in using tools. In order to determine an accurate grade for each exercise, we evaluate the reports submitted by the students and their answers to the questionnaires. Since we receive the results of the questionnaires immediately through the Web, we use such results to improve the exercises and coach the students. Moreover, the students can also receive their scores in a very short time. Students can compare each other' s scores if they are given access to the statistics. Giving students access to the statistics is regarded as the key to ensuring an environment of awareness [8].

BEST COPY AVAILABLE

4 The results of system operation

Figure 3 represents an example of the operation of the system. Web page number (1) in the figure relates to the state of "Starting the Course." Page (2) is the class registration form. Page (3) gives anchors for information about all 15 exercises included in the course. If a learner selects one of the exercises on the page, he can use the exercise page (4). He can access his record of submissions and re-submissions using Web page (5). After inputting his personal goals using Web page (6), he moves on to the state of "Exercising." When he finishes the exercise, he moves on to the state of "Making the Report" and inputs the questionnaire on Web page (7). The results of the questionnaires are immediately stored in the database. Not only the teacher but also the learners are able to compute the statistics of the results from the database in real time. Page (8) relates to the statistics. Pages (9) and (10) are for teachers' use only. In page (9), each student has 15 check boxes, each divided into an upper and a lower section. If the report evaluation is good in the state of "Waiting for the Evaluation," the teacher puts a checkmark in the upper check box. If not, he puts the checkmark in the lower check box and helps the student so that he re-submits his work. Page (10) is useful for analyzing questionnaires stored in the database. The analysis includes the method of data mining [9] implemented in SQL.

Application of the system operation started at the Department of Hiroshima City University in April 1999. This system motivates students to do their exercises, provides good communication between participants and teachers, and reduces teachers' workload. The evaluation results of questionnaires and examinations related to the exercises are as follows:

(1) Ninety percent of students studied for 0.5-2.0 hours at their homes and were interested in the lecture.
(2) Twenty-six percent of students spent less than 2.0 hours preparing the report and exercising, 53% spent 2.0-5.0 hours, and 21% spent more than 5.0 hours, not including class work.
(3) Seventy percent of the 12 students (25%) previously mentioned understood the C language. Moreover, all students made progress in their studies.
(4) Ninety-five percent of the students reported good understanding of the algorithms used in the exercises. Eighty-seven percent of the students passed the examinations.
(5) The students acquired good skills at using TGIF, LaTex, and other programs to write reports.
(6) Seventy percent of the students felt that the teacher did his best in the classroom, and 17% of them barely approved of his performance.

5 Conclusions

We proposed a computer exercise model for the course of "Data Structures and Algorithms II" and developed a Web support system for computer exercises using the model. We place great importance on educational methods including "Reading, Writing, and Using an Abacus" so that our students acquire the skills of "autonomous learning and thinking." Computer exercises using the Web system give students a chance to enhance their capabilities of "autonomous learning and thinking" and "creativity." The system run on the Web server has useful functions, some of which are the management of participant registration, identification of learner's goals, web service of exercises, mutual interaction between participants and teachers, management of report submissions, and both provision and analysis of electronic questionnaires to participants. The use of the system resulted in students' motivation to do the exercises, good communication between participants and teachers, and a reduction of teachers' workload. In order to achieve more concrete results, the students studied more at home and were enthusiastic about doing their exercises. Moreover, the students learned how to make a report using TGIF, LaTex, and other programs.

Acknowledgements

We thank Assistant Professor Dr. Akira Sato of Hiroshima City University for his help with the exercises. We also thank Mr. Jun Ogawa, Mr. Takashi Maesako, and Mr. Kohei Matsumoto, TAs (Teaching Assistants) of Hiroshima City University, for their help with the exercises. This work was supported in part by a Grant-in-Aid of Scientific Research (C) from the Japan Society for the Promotion of Science and a Hiroshima City University Grant for Special Academic Research.

References

[1] Denning P. J., Comer D. E., Gries D., Mulder M. C., Turker A., Turner A. J., and Young P. R.: Report of the ACM Task Force on the Core of Computer Science, Association for Computing Machinery Press (1988).

[2] Computer Science Educational Curriculum for B. A. Degree Program in Computer and Engineering J97, Information Processing Society of Japan, 158p. (1997).

[3] Aho A. V., Hopcroft J. E., and Ullman J. D.: Data Structures and Algorithms, Addison-Wesley (1983).

[4] Leendert A.: Programs and Data Structure in C, Second Edition, John Wiley & Sons (1992).

[5] Fujimoto R., Suganuma A., and Mine T.: Development of a Classroom Management System on the Web, Advanced Research in Computers and Communications in Education (ICCE'99), Ed. by Cumming G. et al., Vol. 55, IOS Press, pp. 756-759 (1999).

[6] Angelo T. A.: Beginning the Dialogue: Thoughts on Promoting Critical Thinking, Teaching of Psychology, Vol. 22, No.1, pp. 6-7 (1995).

[7] Kuhar M. B: Critical Thinking: A Framework for Problem Solving in the Occupational Setting, AAOHN JOURNAL, Vol. 46, No.2, pp.80-81 (1998).

[8] Dourish P. and Bly S.: Portholes: Supporting Awareness in a Distributed Work Group, Proc. of CHI'92, pp.541-547 (1992).

[9] Fayyad Usama M., Piatestky-Shapiro G., Smyth P., and Uthurusamy R.: Advances in Knowledge Discovery and Data Mining, AAAI Press/ MIT Press (1996).

EDASEQ – A log file analysis program for assessing navigation processes

Helmut M. Niegemann
Institute for Media and Communications, Ilmenau Technical University,
P.O. Box 100565, 98684 Ilmenau (Germany). Email: helmut@niegemann.de

Research on the effects of hypermedia learning environments often suffers from a lack of systematic control of learning conditions, especially the sequencing of the content. While available tools for logfile analysis are confined to delivering frequencies and other figures, the tool to be presented (EDASEQ: Exploratory Data Analysis for Sequential Data) was developed to facilitate the analysis of the navigation paths of single learners as well as "average" paths of a group of learners. Because standard statistical procedures for handling sequential data are not suitable here, the tool is primarily founded on graphical methods. Navigation processes are represented by transition matrices, and with additional visualizations and trajectories. Apart from descriptive portrayals, the tool also allows for categorizing empirically found navigation patterns on the basis of theoretically defined prototypical patterns. Furthermore, it is possible to compare the patterns of single learners or groups. Results can be used to better explain the effects of self-regulated learning in hypermedia learning environments. Without knowing variables like sequencing, time-on-task, or the number and configuration of examples studied by learners, it is hardly possible to interpret the impact of external learning conditions on the learning outcomes.

Keywords: **learning processes, navigation, hypermedia, methodology, tool**

1 Introduction

A fundamental problem of research on self-regulated learning is the possible variation of learners' behaviors, especially regarding variables like the sequence of content, the time spent with studying different parts of subject matter, the number and arrangement of examples and exercises: Have they really worked through all the relevant information? How many examples were chosen, with what methods of representation and in what combinations? How many exercises were worked through, and to what result, resp. with mistakes of what kind? How long were the learners occupied with what contents? This is valid for every type of research on self-regulated learning, but especially for learning with hypermedia. Even with the same context conditions, quantitatively and qualitatively completely different courses of learning are possible and thus, in consequence, very different results. Even when the learner activities displayed are described exactly, there are differences with respect to the quality of the elaborative treatment; the external conditions of the learning processes, however, are principally controllable. Unfortunately, standard statistical procedures are not suitable to represent an "average path" in an educational hypermedia system: Mean times spent on looking to specific pages or mean frequencies of visits are often not sufficient to explain differences in learning outcomes.

2 Aims of the development of EDASEQ[1]

For the description and categorization of such processes there thus remain graph theoretical procedures. There were already attempts at implementing these some time ago; the best known is probably Flanders' (1970) procedure for the analysis of teaching (cf. also Canter, Rivers & Storrs, 1985). For the treatment and

---

[1] Supported by the Deutsche Forschungsgemeinschaft (German Research Foundation), grant Az. Ho 649/9-1,2,3).

evaluation of data on the basis of graph theoretical considerations there is, however, as yet no method which is relatively simple to use. It was therefore an aim of the development of methods within the framework of a six year research project on case-based hypermedia learning environments in vocational training to develop a procedure allowing recorded data of learning processes to be so prepared that a) a data reduction is brought about which allows those processes to be analyzed exploratively, b) a categorization of typical processes becomes possible, c) records of several processes can be aggregated and finally d). Comparisons are made possible between (1) single records of processes, in order to see differences and similarities, (2) an individual process and an aggregated one, in order to be able to study deviations of single learners from the typical route taken in their group, (3) two aggregated processes, in order to compare groups under different treatment resp. marginal conditions using experimental designs, (4) a single or an aggregate process with a prototype process that is produced artificially, in order to categorize processes of one or several prototypes within the framework of defined deviations, or to test hypotheses. Apart from the characteristics of the processes, it should also be possible to extract simple statistics: e.g. frequency of the calling up of specific screen pages, specific transition frequencies, length of stay etc.

3 Forms of representation

In order to represent hypermedia navigation processes, there are first of all two different but mathematically equivalent codes: transition matrices on the one hand and aligned graphs on the other. Whilst one can see conspicuous characteristics in the graphical representation, the matrix representation allows the calculation of indices. Since both forms of representation are practicable, both should be taken into consideration. One special feature of well designed hypermedia learning systems is a structured presentation of knowledge given in such a way that learners have the choice of either informing themselves superficially or of going deeper into the subject at any chosen place, or of combining both courses of action: first gaining an overview, then deepening their knowledge. In order to determine the extent of the "deepening" - assuming an appropriate structuring of knowledge in the medium -, two characteristic values, the mean "depth of elaboration" and the "variance of elaboration" have been developed. The depth of elaboration is a rating for every hypermedia occurrence, which is all the higher, the deeper the corresponding screen page goes into a specific subject. If, for instance, the highest level with the index number 1 is the term "statistics", then pages on the subject "inference statistics" or "descriptive statistics" would have the index number 2 and a page on the subject "log-linear models" would have, for example, the index number 5. The arithmetic mean of the values of all screen pages visited could then give an indication of the extent of the "deepening" or "elaboration" of the material; the measurement is completed by the elaboration variance ascertained analogously. Not least, characteristics of the chronological process should be portrayable.

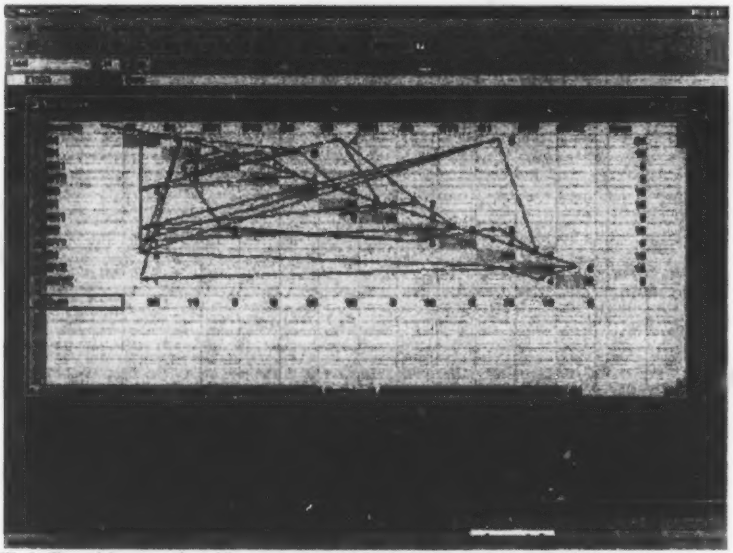
4 Realization

As the first step towards a reduction of process data in the Mannheim research project "Case-based learning problem" - in compliance with the demands - a software-technical evaluation procedure was developed. This enables processes to be transferred rapidly into transition matrices, so that firstly the simple frequencies of the consultation of specific pieces of information and of the transitions between offers of information can be ascertained. The learning programs developed in this project each encompass approx. 150 screen pages; learners need up to five hours to complete the given tasks and corresponding records comprise 3000 - 5000 single entries, each consisting of the time (in seconds after midnight) and the designation of the respective screen page. Log-files existing as ASCII text files are downloaded and converted into MS Excel files. For the simultaneous treatment of a larger amount of records it is also possible to stack them. Process data in the form of transition matrices can furthermore be compared to each other and also aggregated. In order to reduce data one can also stipulate that transitions which are more seldom than a specified threshold value should be ignored.

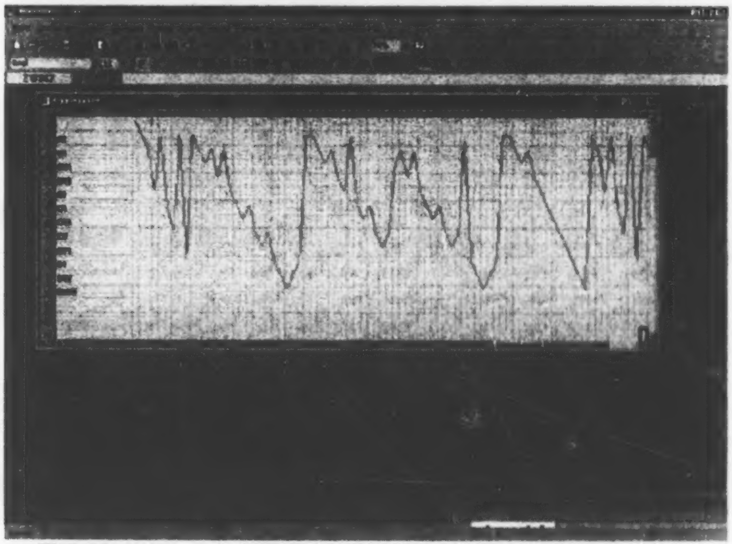
5 Examples of process representations and indices

The following representations are based on fictitious data; i.e. records were produced with the specific aim of representing certain processes, in order to determine whether the corresponding characteristics are perceptible. Apart from this the size of these records was to be restricted, in order to enable a written account to be given. shows the evaluation as regards the frequency with which single screen pages were called up, as well as the length of the stay there (absolute in seconds and relative to the complete time needed). Ills. 1 shows a transition matrix with aligned graphs of the process included (option). One alternative graphical representation ("chronological") is given in Ill. 2. Here, above all, recourses to previous steps are clearly to be seen: the test person would, in this case, have chosen a strategy whereby he/she began by choosing page B1 on the higher level, "deepening" from there straight to BX1, going back to B1, choosing another "deepening" (BY2) etc. The values in the main diagonal indicate how many time units the learner has here stayed on each separate page.

In a third, more concise representation of the process every node (page, screen, chapter etc.) is represented by one cell and the navigation process is shown by arrows between the cells. Analyzing aggregated data, the thickness of the arrows indicates the frequency of the transitions between two nodes. So, a sequence of thick arrows represent a "modal path", i.e. a path used by many users. (Ill. 3)

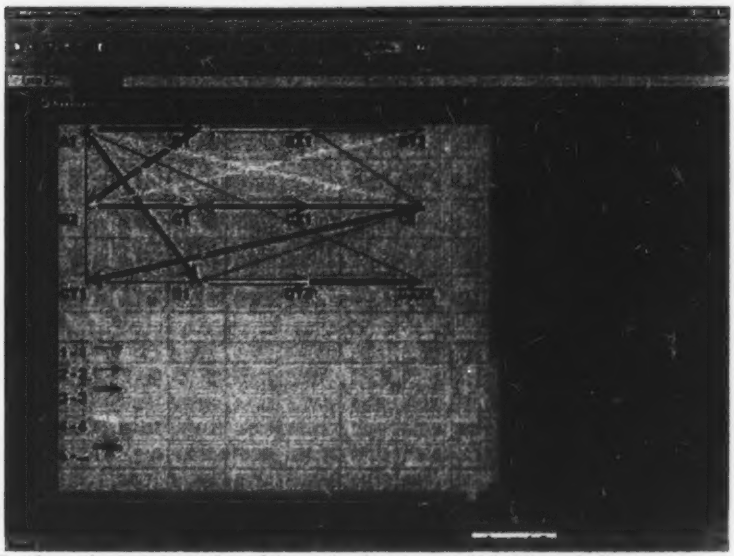


Ill. 1: Transition matrix with process graph included (A1, B1 etc. indicate screen pages)



Ill. 2: Linear representation of the process (A1, B1 etc. indicate screen pages)

BEST COPY AVAILABLE



Ill. 3: **Alternative representation of the navigation process (A1, B1 etc. indicate screen pages)**

6 Conclusion

The procedure which has been developed is first of all explorative, i.e. data are so prepared and represented that they allow categorizations and comparisons, thus offering a basis for the forming of hypotheses. Very extensive record files, in particular, are reduced. Although the procedure for the analysis of records on navigation was developed in hypertext, resp. hypermedia systems, it is also suitable for the treatment and analysis of data on the observation of teaching or other courses of communication.

References

[1] Bishir, J. W. & Drewes, D. W. (1970). Mathematics in the behavioral and social sciences. New York: Harcourt, Brace & World.

[2] Canter, D., Rivers, R. & Storrs, G. (1985). Characterizing user navigation through complex data structures. Behaviour and Information Technology, 4, no. 2, 93-102.

[3] Clarke, J. & Holton, D. A. (1994). Graphentheorie. Grundlagen und Anwendungen. Spektrum: Heidelberg

[4] Flanders, N. (1970). Analyzing teaching behavior. Addison-Wesley: Reading.

[5] Olson, G. M., Herbsleb,J. D., & Rueter, H. H. (1994). Characterizing the Sequential Structure of Interactive Behaviors Through Statistical and Grammatical Techniques. Human-Computer Interaction, 9, pp. 427-472

[6] Sanderson, P. M. & Fisher, C. (1994). Exploratory Sequential Data Analysis: Foundation. Human-Computer Interaction, 9, pp. 251-317

BEST COPY AVAILABLE

Evaluating educational multimedia: a case study

Elizabeth A. Kemp and Raymond H. Kemp
Institute of Information Sciences and Technology,
Massey University, Palmerston North, New Zealand
E.Kemp@massey.ac.nz, *R.Kemp@massey.ac.nz*

Following constructionist principles, postgraduate students who were studying a paper on Human Computer Interaction were required to build educational multimedia systems and then to evaluate those produced by their colleagues. The experience of developing a multimedia system, together with lectures and access to general material on the topic, enabled them to provide valuable insights into important issues. Nonetheless, the students were not, on the whole, able to transfer all that they had learned when building their own systems into an evaluation framework. The provision of scaffolding was recommended to facilitate transfer.

Keywords: **Multimedia, Evaluation, Constructionism**

1 Introduction

What are the criteria that should be used to judge the effectiveness of interfaces for multimedia tutorial systems? In an experiment with a class of postgraduate students studying Human Computer Interaction (HCI), they were asked to develop their own framework for evaluation. To give them some notion of what to look for and what to expect, they first had to form groups and construct their own multimedia tutorial systems. This approach is based on the idea of constructionism [6]. By collaborating in a group to develop some appropriate product, it is suggested that learners can come to a better understanding of the principles of a subject rather than by just being given the information by a teacher. This is in line with the wry comment from Jonassen *et al* [9] that the people who learn most from instructional materials are the designers.

The students were required to work together with one or two other classmates to produce their own small scale multimedia educational systems. Using the knowledge and experience they had gained, they then had to individually evaluate the interfaces of the other systems. There was no detailed specification about how to carry out these activities. The students had, however, been exposed to the main issues through lectures and discussions. They also had appropriate readings made available to them. The intention, therefore, was to see what the students, themselves, considered appropriate ways of evaluation in the light of their background and their experience in developing multimedia software. An assessment was then made of how much they had learned when building systems and how well the knowledge was applied to evaluating the systems of others.

2 Previous work

Interface evaluation can be carried out for many different purposes. The distinction is usually made between formative evaluation where improvements to a system under development can be determined and summative evaluation which assesses the overall performance [8]. There are a range of methods that can be used depending on the purpose of the study. Preece [12] categorises these purposes as analytic, expert, observational, survey and experimental. Analytic techniques are used to determine the complexity of the interfaces. Expert evaluation involves inviting people experienced with interface issues to identify usability problems. Observational, survey and experimental studies all have in common the involvement of what Preece terms "Real users." Users can be observed using software, provide feedback about the system through interviews or questionnaires or take part in experiments to test the impact of various features of the interface.

A common method of evaluation that does not involve users is expert evaluation where, as noted above, people with some knowledge of interface issues detect possible problems. This process can be conducted in accordance with the guidelines formulated by Nielsen and Molich [11]. The following aspects of the interface are all considered in what is referred to by these authors as a heuristic evaluation: simple and natural dialogue; speaking the user' s language; minimising user memory load; consistency; feedback; clearly marked exits; short cuts; good error messages; prevention of errors, and help and documentation.

An examination of the literature on multimedia reveals little mention of evaluation. Testing is usually discussed but not evaluation [4, 15]. Some important principles emerge, however. Alty [1, p33] points out that "A key question is when to use which media and in what combination to achieve the maximum effect." He also observes that success in multimedia depends more on the *combination* of media rather than on the provision of a rich set of media. Frater and Paulissen [5] note that interactive tutorials should allow the user to choose the starting point and allow the information to be accessed as often as required. They also offer this piece of advice. "Keep in mind that multimedia can make learning much more interesting when animation and sound files are used to explain the topic. Also a quiz is more fun when set up as a game" [5, p362]. Preece [12] points out that navigation, too, is an important consideration in hypertext/multimedia systems. Users, as she notes need to be able to know where they are, how they reached that point, where can they go next and how they get there. This as pect of interface design is actually covered by the first heuristic of Nielsen and Molich [11] which refers to "Simple and natural dialogue." This takes into account navigating through a system. Interface factors in interactive multimedia systems are also considered in Reeves and Harmon [13] and Tannenbaum [14].

One recent taxonomy in the literature provided by Heller and Martin [7] aims to help students on multimedia courses understand the forms of media as well as enabling them to evaluate the work of others. It has two dimensions - the media type and the means of expression (elaboration, representation and abstraction). This classification shows, for example, that text might be fully elaborated (large chunks of narrative), can be abbreviated (represented in bullet points) or might be abstract in nature such as text in a logo. Students are able to check whether a medium has been used in an appropriate fashion. As the authors state, though, the taxonomy takes no account of the effect of combining several media. Nonetheless, it is useful in focusing on the evaluation of each element. Detailed guidelines about how to use each medium, for example text, can also be found in Vaughan [15] and Collins [2].

3 Course structure

"Topics in Human-Computer Interaction" is a single semester paper for postgraduate students in Computer Science and Information Systems at Massey University. Most students have already completed a third year undergraduate paper "Human-Computer Interaction" in which the underlying theory is presented. These students will also have gained some experience in developing interfaces. The aim of this course is to consider issues of current interest such as computer supported co-operative work, innovative interfaces, different ways of evaluating the interface, multimedia systems and interfaces on the World Wide Web. Teaching is carried out through a mixture of lecturing, student seminars, discussion and demonstrations (of software such as Adobe Premiere and Macromedia Director). Students have available to them two books of readings which cover the material taught.

One assignment for this paper involved the students working in groups to develop a small multimedia system with an educational focus. The groups could choose any appropriate subject. Each student was then asked, individually, to evaluate the interfaces to all the other systems. A set of lectures had been given on the topic of multimedia including exposure to several life cycles for developing software of this kind. The topic of evaluation had also received considerable coverage in lectures and student seminars. Students were aware that interfaces can be evaluated for various purposes and in many different ways (for example by heuristic evaluation, interviews, questionnaires etc.)

Guidance on the life cycle that should be followed to develop the multimedia systems and the method of evaluation required was deliberately kept to a minimum. In the light of the teaching on the course and the material available to them, students were expected to make their own informed decisions. In particular, it was hoped that the students' own experiences in developing multi-media software would give them some insight into the criteria that should be employed when evaluating the interfaces to the other students' systems.

4 The student systems

Six groups each developed their own multimedia system. The systems were expected to offer instruction to their users and be interactive. A brief description of the systems follows.

Maori Language Tutoring
This system was designed to help students learn the Maori language. The study material was based on the philosophy that Maori be used wherever possible, with visual and aural stimuli to teach the vocabulary. Words were introduced via demonstrations using pre-recorded video clips. The system, however, also contained explanation in English for students who did not wish to completely immerse themselves in Maori. As well as learning new terms, students could choose to review vocabulary or test their comprehension. Maori music and designs were used in this system where the developers thought appropriate.

Learning the New Zealand Road Code
A written test on the New Zealand road code has to be passed before learner drivers can take their practical driving test. The aim of the road code system was intended to make the learning process more interesting. It was believed that by using animation, audio and video, the learning process would be enhanced. The system included tutorial material on aspects of the road code (for example, how to overtake or what to do when approaching a roundabout) as well as test material.

Earthquake Disaster System
The earthquake disaster system was developed to show people how to behave in the event of a serious earthquake. It included clips from a video developed by Civil Defence. Topics that were dealt with included planning for and coping with an earthquake. The opening screen showed a photograph of the devastation caused by a major earthquake. Music and animation chosen to reflect the theme of devastation accompanied the photograph.

Shape Recognition
The intention of the shape recognition system was to help children learn how to identify both two and three dimensional shapes in a lively and interesting way. Sound, animation and graphics were included in order to make the system appealing to children. Another goal of the developers was to make the system easy to use. There was a particular emphasis on the use of colour which was seen by the developers as making the system attractive to the intended users. The opening screen was designed to capture the attention of children with music and morphing shapes.

Introducing the Internet
This system, as its name implies, was intended to be introductory in nature. Its target group was school children who could find out about concepts such as email, newsgroups, file transfer protocol etc. This system made use of graphics and sound but also included lengthy textual explanations. As with the shape recognition system, there was an emphasis on the use of colour. Ease of navigation was also a major consideration.

Undergraduate Studies in Computer Science
This system allows students to find out about the staff and the papers they teach in a Computer Science department. Photographs of staff members were included. When browsing through the system, users were able to move from a staff page to obtain information about papers taught by the staff member. Contextual information about the location of the building where the Computer Science staff were housed was also provided. The opening screen of the system showed a picture of the university grounds. Other pictures could also be viewed.

5 Educational Issues

Although the course does not deal with issues of computer-based learning, this was the focus of the assignment and gave the students some context for the systems they produced. They were expected to choose an approach to teaching which was appropriate for the subject that was being taught and that they felt would be effective in a multi-media setting. They all propounded he philosophy of their systems during their presentations. It is interesting to compare the different approaches that the students chose for their systems and how this was reflected in the presentation styles.

The Maori language teaching system immerses the student in the subject and attempts to teach by example. As noted earlier, the system can be used without reference to English words or phrases. Maori, like various other languages such as Japanese is very much bound up in the culture of the people and so this approach seemed entirely appropriate. Maori songs, words and phrases in a commentary with accompanying visuals provided a backdrop that was both stimulating and educationally appropriate.

The road code system contains video clips produced by the students themselves which graphically illustrated both correct and incorrect procedures to be followed in various situations when driving. This could be regarded as teaching by presentation and illustration.

Like the road code tutorial, the earthquake disaster system has an emphasis on illustration using video clips and contains other factual information in an appropriate form.

Unlike the previous systems, the shape recognition tutor includes trial and error examples for the student to consider. It takes into account the answers the student gives and does not continue until it judges s/he has fully understood all the current concepts. It could be regarded as a mastery system from this point of view.

The internet system contains a great deal of information in a text-based format, but the presentation was enhanced with appropriate animations. Material is set out in an simple to follow form and subjects can easily navigate around the system to discover what they need to know.

The undergraduate studies in Computer Science system also allowed students to learn about the department of Computer Science in a discovery mode. In some senses this was the package that was the least like a tutorial system, since it just provided information in a non-instructional form.

The underlying objective of the assignment was to determine whether or not students had assimilated a fundamental principle of HCI - that issues concerning functionality should not be divorced from interface concerns. Given the experience of developing a multimedia system, it was hoped that students would take into account the educational aims of the system as well as the multimedia features. It was not the object of the exercise, however, to see whether effective learning took place. It was expected that some variation of expert evaluation would be followed. What was of interest were the criteria that students incorporated into their checklist. Issues it was hoped would be addressed (in the light of the literature on this topic) included the following:

whether the interface reflected the educational objectives of the system;
the suitability of the media selected;
the user appeal of the systems;
the interface concerns;
evaluating the execution of the various media.

6 Results

Every student (thirteen in total) appraised all the systems developed by their colleagues. All the students provided a checklist of the criteria used for the evaluation - some were very detailed and others quite brief - from thirty items at one end of the scale to five at the other. The two students with the longest checklists evaluated whether the system fulfilled its objectives, the selection of multimedia components and the execution of the multimedia as well as detail of the interface such as the provision of feedback, ease of navigation etc. There were another three quite comprehensive taxonomies which covered many but not all of the relevant issues. Five students used Nielsen's [10, 11] guidelines for heuristic evaluation without adding to them to deal with the educational or multimedia aspects of the systems. The three students with the short checklists had incorporated rather broad categories such as ease of use, knowledge presentation, navigation, multimedia concerns and quality of knowledge which gave them reasonable but not complete cover of the relevant issues.

Expert evaluation can be carried out by anyone with appropriate skills and by more than one evaluator. In one case, two people evaluated the systems and combined their findings whilst on another occasion the student drew up the framework but did not carry out the heuristic evaluation himself. Some students scored the various items and averaged the results. This enabled systems to be ranked. Others did not attempt to provide an overall score for each system but left the findings to speak for themselves.

1. Did students check to see whether the interface reflected the educational objectives of the system?

In total, eight of the students included questions in their checklist which related to the educational nature of the system. Three of these explicitly mentioned the educational objectives of the systems under review before providing their assessment.

> *"This system is a multimedia tutor system designed to aid students in learning the Maori language. The system uses both visual and aural stimuli to teach words and concepts."*
> *"The system aims to provide information to undergraduate students."*
> *"It aims at helping children to learn a shape through playing which makes learning easy and fun."*

The eight students who considered the purpose of the system, that is its educational aspect, did not all ask the same questions. A variety of issues were covered as follows:

How does the system consider educational objectives?
Is the system suitable for intended users?
Who is the target audience?
Is the system aimed at the right audience?
Does the system have a reasonable informational content?
Is the quality of knowledge sufficient?

The evaluations included comments such as the following:

> *"Good way to teach a student with audio pronouncing the language and seeing the words on the screen."*
> *"Including some information on the properties of the different shapes and showing everyday examples of them would make learning the shapes a richer experience."*
> *"It does not really seem to be an educational system, more an informative system."*
> *"The current system does not seem to have a glossary page, A page for quick lookups and acronyms and jargon would probably be helpful."*
> *"It might have been good to have an option of telling users what the different shapes look like."*

Some of the students, however, not only evaluated the systems in accordance with their checklist but also in the light of their experience in appraising the programs. They mentioned, therefore, other important criteria in their assessments. One student centred her overall assessment around the suitability of a system for its purpose although this was not included in her criteria for evaluation. Two other students, also, mentioned educational issues such as whether the systems provided adequate content and comprehensible instructions.

> *"I had no idea what I needed to do and how the test was being processed."*

2. Did the students consider whether the mix of multimedia selected was appropriate for the stated purposes of the system ?

Only two students included in the guidelines for evaluation the need to consider whether suitable media were selected and used appropriately. One student asked the question "*Is the multimedia actually of use and not redundant*?" The other student checked that the mix of multimedia was used appropriately. This student noted not only occasions when a particular mix of media was ineffective but also when media was missing.

> *"The current system seems to rely too much on textual information. Improvements would be to make more use of video, diagrams and to provide more navigation options. These changes would give the user a more enriching learning experience."*

Many other relevant comments were made by the other students about an appropriate usage of multimedia, although they did not take the issue into account systematically.

> *"Of all the applications reviewed this has the most appeal due to its excellent usage of graphics and sound. The main area it could be faulted on is the large textual explanations given but these are offset by the following graphical examples."*
>
> *"It uses multimedia such as sound and text making the system vivid and active."*

Only one student fell into the trap of believing that a multimedia system had to incorporate all media. He would criticise a system that did not include video, for instance. No regard was paid to whether adding video would contribute to meeting the goals of the application.

3. Since educational systems have to be appealing to their users, did the students take this factor into account?

With regard to the appeal of a system, this issue was only expressly considered by four students. Related questions were as follows:

Is the system interesting and fun?
Does the user find the system visually appealing?
Has information been presented in an interesting manner?
Has the system an attractive presentation?

Comments made by these students include the following:

> *"Its creative design of the main menu ... and its appropriate use of the sound medium, make it enjoyable to use the system."*
> *"There was no splash screen introduction. Whilst this may seem superfluous, good splash screens can be used to arouse a user's interest."*

Three other students, however, did mention this issue. One of these was the student who did not carry out the expert evaluation himself. After watching the evaluation (according to Nielsen's guidelines as specified), he realised that the system he preferred obtained the lowest rating. He proceeded to base his overall assessment of the systems on whether they had an interesting and attractive interface. A second student also focused on the interest or lack of it in the programs. Of the Maori tutor, she said " *The welcome interface is impressive. The background and the music gives me some feeling of Maori culture.*" According to her, another system was a little bit boring.

An issue that relates to the appeal or attractiveness of a system is the appropriate use of colour. Four students included at least one item in their checklist concerning colour. Questions were as follows:

Are too few or too many colours used?
Is the colour in the system beautiful?
Does the use of colour help to make the displays clear?
Is the use of colour bad, normal, good or excellent?

One system was notable for its use of colour and several comments were made about this

> *"The very colourful shapes used are appropriate for the school based children as seen as being the intended users."*
> *"The colour used in the system is beautiful."*
> *"Good colour choice, relaxing."*

This was not the only the system to make effective use of colour, however and one student observed in his conclusion that no-one made the mistake of using too many colours.

4. What typical interface factors were considered?

All of the students checked for at least one well-known interface concern such as consistency, clearly marked exits etc. Seven of them specifically included the guidelines for heuristic evaluation by Nielsen and Molich [11] or the updated version by Nielsen [10] in their checklist.

It was also expected when considering interface issues that the importance of navigation in interactive instructional systems should be recognised. It should not be just one more item in a checklist. Eleven of the 13 students took account of this issue.

> *"No stop, rewind or scroll bars for video."*
> *"Gives reasonable freedom to navigate backwards and forwards."*
> *"Not very flexible, very linear in its execution."*
> *"It is very easy to get "lost" while navigating through the system. No "back" button provided."*
> *"Clicking at various places in the window may move you to unexpected screens."*
> *"With the test screens there is no title indicating this."*
> *"Have no idea what I am supposed to do in the first screen."*

Four of the students highlighted the importance of navigation. Three incorporated this into their framework as a high level criteria. A fourth not only checked how users moved around the system but whether or not the users would know where they were in the system.

5. Did the students evaluate the multimedia components of the system?

Four students evaluated the execution of the individual media. Two of these assessed the effectiveness of each component: video, sound, graphics, text etc. by rating them on a scale. The third student concentrated on text and icons. His section on text was quite detailed, checking the length of the sentence, whether it just focused on one issue, and whether there was sufficient white space around it. The fourth student checked that the multimedia was not "over the top".

> *"When the system explained the Maori words, text is well organised."*
> *"I liked the use of Maori music with the splash screen."*
> *"Liked the introduction - morphing shapes."*
> *"Widely accepted icons are used to aid page-based navigation."*
> *"The background music is excellent. The button clicking sounds great."*
> *"Image excellent. When the system first starts, the animation is creative and attractive."*

7 Discussion

Reflecting on the results of the assignment, it became clear that learning about multimedia evaluation took place at various points in time. Most of the systems developed by the students were stimulating to watch. As developers the students were clearly aware of the need to use appropriate media in suitable combinations [1] and of the requirement to navigate easily through the system [12]. Some of what they had learned was reflected in the checklists that they developed for evaluating the systems of others. There was a difference, however, between the criteria specified by students for evaluation and those actually used when making their overall appraisals. These sometimes took additional factors into account that had not been included in the stated checklist. The experience of evaluating the systems themselves, allowed further learning to take place. It will be the more complete list of factors that are considered in the remainder of the discussion since the experience gained from carrying out appraisals is important and should not be discounted.

Eleven students checked to see whether the interface reflected the educational objectives of the system and two of these also considered whether the mix of multimedia was appropriate for the stated purposes. All of the students considered at least one relevant interface factor (consistency, clearly marked exits, etc). Six of the students also realised the need to find out whether or not a system would appeal to users. Four students included assessment of media components in their appraisals, however none of their questions showed a deep understanding of media issues.

It was pleasing from an educational perspective that most of the students when carrying out their evaluations took account of the functionality of the system. This cannot be divorced from interface considerations as for many users the interface is the system and must deliver the appropriate functionality.

Interface issues, too, were seen as important by all of the students. Of these, 11 checked to see whether a user could easily navigate around the program. This is an important issue in interactive multimedia systems and was recognised as such by the students. Eight of the students carried out a reasonably comprehensive evaluation of traditional interface concerns but for five it was rather rudimentary. This was surprising given the emphasis on the heuristic evaluation in the undergraduate and post-graduate courses.

Overall there were only two students whose evaluation was limited to just those interface issues covered by Nielsen [10, 11]. This meant that they excluded educational considerations, the appeal of the interface, an evaluation of the individual media and whether or not they were used in appropriate combinations.

A major weakness in the student evaluations' overall was the failure to consider whether the mix of multimedia selected was appropriate for the purpose of the system. Whilst the students did consider educational issues at a high level, they found it difficult to move to a detailed perspective, that is were suitable media selected and combined? This may involve greater knowledge of the potentialities and problems of the individual media than the students possessed. They tended, therefore, to have an overall impression of a system. This was reflected again in the failure of two thirds of the students to evaluate the execution of each media component.

Around 50% of the students did not take appeal/interest and fun sufficiently into account. This can possibly be attributed to the fact that they were not the intended users of the systems. If they had been drawing up a list of questions for users to answer they may have incorporated this. Nonetheless, it was an important omission as multimedia systems set out to interest and hold the attention of their users.

As the above discussion shows, students were particularly weak in considering what was to them the new area of multimedia. They did not appear to have the knowledge or experience to determine how to evaluate the media. They were given some exposure to these issues in lectures but do not appear to have followed them up. Whilst no one student came up with a complete checklist for evaluating multimedia systems, amalgamating the items in their checklists enables a comprehensive framework to be developed. See Appendix 1 for the main features of this. In future it may be preferable to provide students who have built a multimedia system with some scaffolding to help with the evaluation phase. Scaffolding [3] refers to supports that can be provided by a teacher to students. The main headings in the taxonomy outlined in the Appendix could be provided. The students could then be asked to develop appropriate questions for each area.

8 Conclusions

The students learned a great deal by building multimedia software and evaluating the systems of others. This was reflected in the perceptive comments of the students made in their written assignments. It was not always reflected, however, in the frameworks for evaluation that they developed, only two of which were comprehensive. Certain areas were handled well by the students, for example checking that each system was suitable for its purpose and the importance of navigation. Two significant issues, though, were only identified by a minority of the students – the need to choose appropriate media and to determine how well they had been produced. It appears that because the area of multimedia was new to the students, they needed more scaffolding in place to be able to learn from their own experiences. Instead of developing an evaluation framework from scratch, some initial information can be given to students in future that they then have to flesh out.

References

[1] Alty, J. L., Multimedia – "What is it and how do we exploit it?" In D. Diaper & N. Hammond. (Eds.), People and Computers VI, pp. 31-44, Cambridge: Cambridge University Press, (1991).

[2] Collins, A., "What different media do best", In The Six International Conference on Computers in Education, Beijing, (1998).

[3] Collins, A., Brown J.S., & Newman S. E., "Cognitive Apprenticeship: Teaching the craft of Reading, Writing and Mathematics", In L. B. Resnick (Ed), Knowing, Learning and Instruction, Hillsdale, New Jersey: Lawrence Erlbaum, (1989).

[4] England, E., & Finney, A., "Managing Multimedia", Harlow: Addison-Wesley. (1996).

[5] Frater, H., & Paulissen, D., "Multimedia mania : experience the excitement of multimedia computing", Grand Rapids: Abacus. (1993).

[6] Harel, I. (Ed.), "Constructionist Learning", Boston: MIT Press, (1990).

[7] Heller, R., & Martin, C. D., "A Media Taxonomy", IEEE Multimedia, 2(4), 36-45. (1995).
[8] Howard, S., & Murray, D. M., "A Taxonomy of Evaluation Techniques for HCI", In H. J. Bullinger & B. Shackel (Eds.), Human Computer Interaction. Interact' 87, pp. 453-459, Amsterdam: North Holland. (1987).
[9] Jonassen, D. H., Wilson, B. G., Wang, S., & Grabinger, R. S., "Constructivistic uses of expert systems to support learning". Journal of Computer Based Instruction, 20(3), pp. 86-94, (1993).
[10] Nielsen, J., "Enhancing the explanatory power of usability heuristic", Proc. ACM CHI'94 Conf. (Boston, MA, April 24-28), 152-158. (1994).
[11] Nielsen, J., & Molich, R., Heuristic Evaluation of User Interfaces. In J. C. Chew & J. Whiteside (Eds.), Proceedings of CHI' 90: Human Factors in Computing Systems, pp. 249-256, New York: ACM Press. (1990).
[12] Preece, J., "Hypermedia, multimedia and human factors". In C. Latchem, J. Williamson, & L. Henderson-Lancett (Eds.), Interactive Media, London: Kogan Page, (1993b).
[13] Reeves, T. C., & Harmon S., "Systematic evaluation procedures for interactive multimedia for education and training". In S. Reisman (Ed.), Multimedia Computing: Preparing for the 21st Century, London: Idea Group Publishing, (1994).
[14] Tannenbaum, R. S., "Theoretical Foundations of Multimedia", New York: Freeman, (1988).
[15] Vaughan, T., "Multimedia: Making it Work", Berkeley, Cal: Osborne McGraw-Hill. (2^{nd} ed.). (1994).

Appendix 1

1. Does the system meet its objectives?
    - Who is the target audience?
    - Is the system suitable for the target audience?
    - Does the system include (in the case of educational systems) sufficient content?

2. Has an appropriate mix of multimedia been selected?
    - Have sound and text been used effectively together?
    - Have sound and graphics been used together effectively?

3. Will the program appeal to users?
    - Is the system fun?
    - Will the user find the system visually appealing?
    - Has the system a features that will pall over time e.g. an unusual sound or joke?
    - Has colour been used in an appropriate fashion?

4. Has the interface been properly constructed?
    - Is the interface consistent ?
    - Is help available when necessary?
    - Can users easily navigate around the system?
    - How does the user navigate around the system?
    - How does the user know where s/he is?
    - Is progression through the program logical?
    - Can the user start and stop as required?

5. Have the individual media been well-executed?
    - Is the text /graphics,/sound etc well produced?
    - Are the sections of text too long/too short?
    - Will the text be understood by the target audience?
    - Has text been expressed using elaboration, representation or abstraction?

Evaluation of class organization in the computer literacy education

Akira Harada*, Michio Nakanishi and Masashi Komori***
** School of Human Sciences, Osaka University*
Yamadaoka 1-2, Suita, Osaka 565-0871, Japan
E-mail: {harada, komori}@hus.osaka-u.ac.jp
*** Cybermedia Center, Osaka University*
Machikaneyama 1-30, Toyonaka, Osaka 560-0043, Japan
E-mail: naka@cmc.osaka-u.ac.jp

This paper compares two grouping strategies for teaching computer literacy at the university. The authors and their colleagues have been involved in the computer literacy education to 180 freshmen majoring in Letters and 150 freshmen majoring in Human Sciences for five years. In 1999, 180 students were organized into three classes at the early stage of the semester according to the student's wish, whereas 150 students were reorganized into three classes based on an achievement exam in the middle of the semester. The statistical analysis of exams and students' self-assessment showed that the early class organization was not so effective compared to the mid-term reorganization. The effect of mid-term reorganization was significant in the slow-learners class.

Keywords: **class organization, computer literacy education, self-assessment, teaching strategy**

1 Introduction

Computer literacy education in Japanese colleges and universities is facing a problem of diversity of students' computer skill levels. The reason for this is twofold. One is that very few high schools introduce the computer literacy education is into their curriculum. The other is that as computer price is falling down the number of students is increasing who have learned how to use word-processing or e-mails by themselves at home. This problem led us to study how to help our students learn this subject in good quality.

In Osaka University, the computer literary education has been a required subject for all freshmen since 1994. The computer literacy course consists of 15 sessions, and each session lasts 90 minutes, which includes demonstrations by a teacher and hands-on activities by students. Usually an assignment for each session is also given which will take an hour or two to complete. Three teachers including the authors have been teaching the computer literacy course to over 150 freshmen majoring in human sciences, and our three colleagues have been involved in teaching to 180 students majoring in letters.

In 1999, 150 students majoring in Human Sciences were organized into three parallel 50-student classes according to the enrollment order before the first session. In the middle of the semester, we gave an exam that includes hands-on work, such as word document processing, consulting online dictionaries, and finding web sites. Then we reorganized the three classes based on the exam score. Other background variables (age, gender and future academic field) were not considered for the class organization. The class organization aimed at ability grouping, that would provide non-experienced students with a slower work pace and allow high-achieving students to be sufficiently challenged by more demanding lessons. At the end of the semester, we again gave them an exam that would measure how they made progress.

As for the 180 students majoring in Letters, three parallel 60-student classes were reorganized according to the students' wish based on the questionnaire survey at the fourth session of the course. That is, the keywords of the three new classes, "slow and steady", "intermediate" and "intensive" were shown to students, and each student chose one of the classes.

In this paper, we begin with related work and a brief explanation of our computer literacy course, followed by the methodology of the class reorganization. Then, we present the statistical data analysis to show that class reorganization in the middle of the term was effective.

#1 Change this plain text file to rich text format, then change the font of the marked words to Ryumin 12 point, and place it in the center.
#2 Explain how to use Japanese Kana-Kanji translation and how to register your name in your own dictionary.
#3 Look up the three words (omitted here) in the following dictionaries: English-Japanese, Japanese-English, and Webster.
#4 Draw a tiny picture and insert it into this page.
#5 Find URLs of the National Diet Library and any two online book stores.
#6 Look into "/SharedLibrary/Literature/" and describe what's in it.
#7 What should be considered when you decide your password string?
#8 Find the specified string in the large file and copy the paragraph to the answer sheet.
#9 Describe how to cope with chain mails.
#10 Describe how to limit the line length to fewer than 65 characters in the body of an e-mail.

Table 1 Midterm exam sample in 1999

Touch typing	(poor) 1 2 3 4 5 (excellent)
Mouse operation (click, double click, drag)	(poor) 1 2 3 4 5 (excellent)
Window operation (resize, move, iconify, hide)	(poor) 1 2 3 4 5 (excellent)
Japanese Kana-Kanji translation	(poor) 1 2 3 4 5 (excellent)
File/Folder operation (move, rename, create)	(poor) 1 2 3 4 5 (excellent)
Word document processing (fonts, centering, insert graphics)	(poor) 1 2 3 4 5 (excellent)
Mail (MIME, signature, save to file, reply, delete, re-file)	(poor) 1 2 3 4 5 (excellent)
Web (search engine, book-mark)	(poor) 1 2 3 4 5 (excellent)
Use of online dictionary (Japanese, English)	(poor) 1 2 3 4 5 (excellent)
Canceling your printer job	(poor) 1 2 3 4 5 (excellent)

Table 2 Questionnaire survey for self-assessment

2 Related work

Although there have been much previous research on ability grouping, tracking, and class organization, they are mainly for K-12 school education, e.g. [4,9,10]. Furthermore, as far as the authors know, there has not been any research on class reorganization in the middle of a semester for computer literacy education. The authors have tried class reorganization for five years and presented its result obtained before 1998 in [5]. Our reorganization method is basically based on the exam score, but is not the same as cluster grouping.

3 Computer literacy education

Since the 1970s, the definition of computer literacy has evolved, and many researchers have discussed the courseware and teaching methodology of the computer literacy course, e.g. [2,3,4]. The authors believe that to learn details of word processing and spreadsheet application is not important but to grasp the concept and principal facilities of those applications is a key for students to become literate. Furthermore, the attitude to learn by himself or herself is also a key.

In the latest syllabus of the computer literary course in Osaka University, topics consist of two categories, "*Requisites*" and "*Options*".

Requisite category consists of the following items.

- File system, file operation, floppy disks
- Word processing, kana-kanji conversion (for Japanese characters)
- Concept of the Internet, network etiquette
- Electronic mail, web

- Draw and/or paint software
- Spreadsheet

Options are

- Net news
- LaTeX with graphics
- Writing HTML
- Mathematica
- SAS (Statistics)
- Script languages (perl, awk, shell, etc.)
- Computer ethics, social problems

Since one course session lasts 90 minutes and is held once a week, all topics of requisite category are the minimum competencies and are covered in about seven weeks. For the rest of one semester, teachers select some of the items from optional category depending on the students' majors. For example, LaTeX and Mathematica are selected for students majoring in Physics and Mathematics, while spreadsheets and SAS for Economics.

4 Class reorganization in the middle of a term

In this section, we explain the class reorganization method that we adopted in 1999. Then we show the examination scores and self-assessment scores of the three classes.

4.1 Reorganizing three classes by a hands-on performance exam

After we completed topics in requisite category, we set a mid-term examination that demands 1-hour hands on work, because there were differences between students how fast they got accustomed to computer operations in class. Table 1 shows the questions of the mid-term exam. We marked the examination papers out of 100 (each question of 10), and used the scores to reorganize the classes. The students who achieved more than 67 points were grouped into class A. The threshold between class B (50 students) and class C (50 students) was 52 points. The average total score was 60.3 (s=15.7).

The average scores of the new classes A, B, and C were 77 (s=7.4), 60 (s=3.9), 42 (s=7.5) points, respectively. The average score of class A students was more than 5.5 for all ten questions, whereas the students who were grouped into class C got only 2.2 and 2.3 for question #5 (web search) and #6 (file search), respectively, which were significantly lower than the other two classes.

4.1.1 Self-assessment by students

Before the mid-term exam, a questionnaire survey paper was distributed to the students. The survey consisted of 10 questions, which would measure students' mastery of competencies taught by that time (Table 2).

The answers to these questions were collected on a 5-point scale. The scores of the collected questionnaire showed a positive correlation between the exam and the students' self-assessments. That is, class A students felt good at the following competencies: inserting graphics into a document, operation of files/folders, and searching web site, whereas class C students answered that they had not mastered those topics. As for searching files from hierarchical file structure, class C students perceived that they were good at it; however, its exam score is poor. This indicates that class C students did not understand the file structure itself. Touch-typing and Email competencies were not statistically significant between three classes.

4.1.2 Curriculum after the class reorganization

The result of the exam and the questionnaire showed us what we should teach in the new classes after the class reorganization. We provided class C students with a slower work pace and revisited those competencies that they were not good at. For class A students, we gave lectures more extensively than other two classes and gave self-teaching assignment of LaTeX in the summer vacation.

In order to allow them to have an active participation in the shaping and augmenting of their learning, we also introduced self-teaching approach for learning spreadsheets in all classes. That is, after a brief explanation given by a teacher, students followed tutorials on the teacher's web pages. We had two teaching assistants each class, we asked them not to teach detailed step-by-step operations to the students but to help the students to find the way by themselves.

4.2 Evaluation of class reorganization

4.2.1 Statistical evaluations of exam and questionnaire

At the end of the course, we gave a self-assessment questionnaire survey followed by the term-end examination, which required hands-on work of about an hour. Here we begin with the analysis of the exam scores.

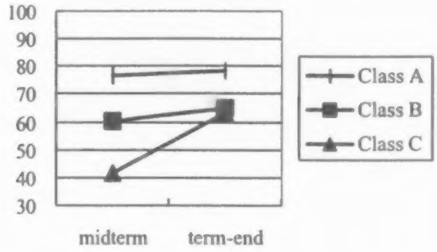


Figure 1 Total scores of midterm and term-end exams

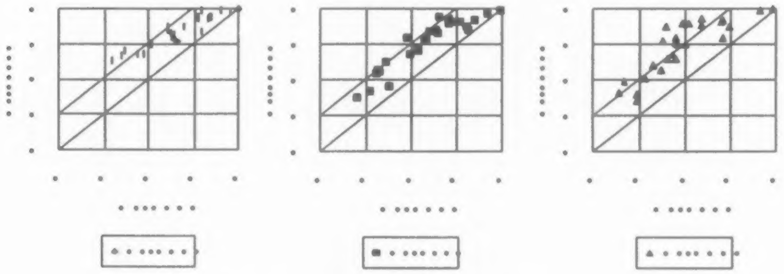


Figure 2 Scores of self-assessment

The total score and the scores of three questions (use of online dictionaries, OPAC search, and limiting line length of Mail body), which are similar in two exams, were considered in a two-way ANOVA. As a result, these four items showed an "interaction" between the two exams and classes ($p < 0.05$).

Figure 1 shows a comparison of the average scores of two examinations. It indicates the existence of the "ceiling effect", that is, the score difference between class A and other two classes decreased after the class reorganization.

As for spreadsheets, two sessions (which means 180 minutes) were assigned for class C, while one session was assigned for class A and B classes using self-learning web based text. But the scores were 8 points in class A and 5 points in class C. The score of writing HTML also supports this tendency. From this fact, it is proved that class A students had higher ability in computer operations than other two class students.

4.2.2 Analysis of self-assessment questionnaire

As for the 27 items that were included both mid-term and term end questionnaires, the average term end exam scores were higher than mid-term scores in all classes in 1998 and in 1999. In Figure 2, the x-axis shows the midterm score, the y-axis shows the term-end score, and each scatter point in the graph represents the score of one item. Two years analysis showed same tendency.

We took the exam timing (midterm or term-end) and the classes as the factors of the two-way analysis of variance (ANOVA). The following four items of the questionnaire shows that there is an "interaction" between the exam timing and the classes ($p < 0.05$).

- Creating a new folder (directory)
- Editing a word document
- Browsing web pages
- Searching web site

We conclude that class C students perceived they were as self-confident in these items as the students in the other two classes.

Though the exam scores are not significantly correlated with students' self-assessments, we consider the class reorganization was effective for slow learners class students, because it is important for them to have confidence in their computer operations.

5 Comparison of class reorganizations

There is another attempt to reorganize classes. The 180 students majoring in Letters chose one of three classes whose lecture policy are "intensive (class A)", "intermediate (class B)" and "slow and steady (class C)". Teachers expected that computer literate students might choose class A, and novice would choose class C.

To evaluate two class organizations, we discuss the term-end exam scores and result of self-assessment.

5.1 Comparison of the term-end exam score

The students in six classes were given an examination at the end of the term. The full marks of each question were ten points. The following five questions are common to all classes.

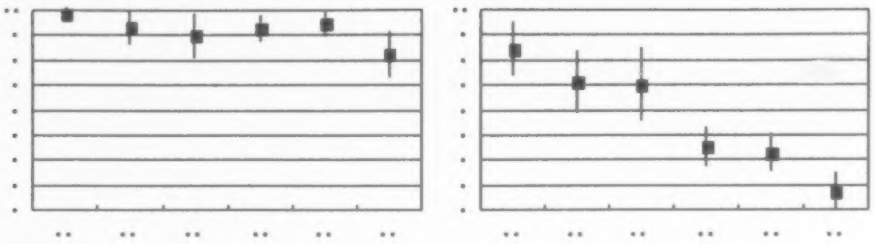
(a) Look a difficult Kanji word up in a Japanese online dictionary.
(b) Explain how to cancel a printing job.
(c) Find Yukio Mishima's book using online public access catalog of the university library.
(d) Explain why 2-byte special characters should be avoided in e-mails.
(e) Show URLs of the companies which sell cars on the web.

In Figure 3, the square(•) indicates the mean score of each class and the vertical line shows the 95% confidence interval of the mean score. To identify a particular class, we use H (for Human Sciences) and L (for Letters) as a subscript of the class name. For example, A_H denotes the "highest-score" class for students majoring in Human Sciences, C_L denotes the "slow-and-steady" class for students majoring in Letters.

The result of the "one-way ANOVA " and the "statistical multiple comparison" shows that questions (a); (b), (c) and (d) have statistical difference ($p<0.05$). Most of the confidence intervals of the class C are bigger than those of other classes, which means the variance of student competencies exists.
The score of the question (b) of "H" classes is higher than "L" classes. This might due to the fact that the operation was not taught in "L" classes.

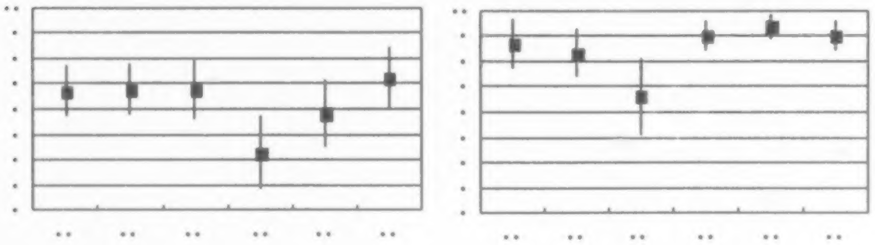
5.2 Comparison of exam score and result of the self-assessment

Before the term-end exam, the same questionnaire survey was also distributed to the L classes. Figure 4 shows the distribution of self-assessment score of two items: consulting on-line dictionaries and canceling a printing job. The "one-way ANOVA " and the "statistical multiple comparison" show that the differences of mean scores among classes were significant in the Figure 4 (a) but not significant in the Figure 4 (b).



(a) Consulting on-line dictionaries

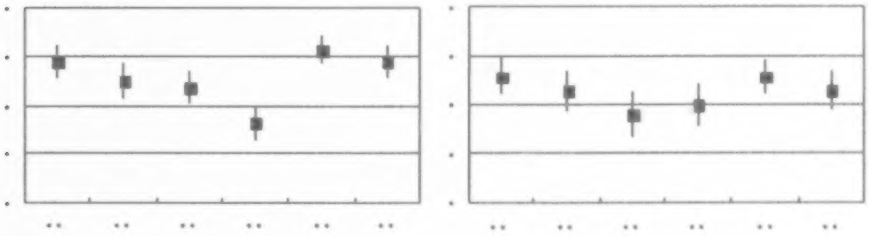
(b) Canceling a printing job



(c) Accessing on-line catalog of the library

(d) Explaining special characters

Figure 3 Distribution of the term-end exam scores



(a) Consulting on-line dictionaries

(b) Canceling a printing job

Figure 4 Distribution of self-assessment scores

The comparison between the exam scores and self-assessment shows that all of students who achieved high mark in the exam don't necessarily perceive that they were very good at it. For example, although the scores are high in Figure 3 (a), the result of the self-assessment is not good.

6 Conclusions

In the first half of the paper, we described the effect of class reorganization in the middle of a term, which has enhanced learning outcomes in computer literacy classes. The class reorganization is also a good tool for teachers to know the way to lead students to higher skill level.

Figure 1 and Figure 2 suggest that many students, especially for those who belonged to class C, have made progress during the latter half of the semester. The progress was brought by the two factors, that is, the students' internal motivation and the class reorganization. Moreover, the "interaction effect" of the two factors must be taken into account as a factorial effect. In order to measure the effect of two factors separately, an experiment based on ANOVA model is necessary. However, the score improvement of class C suggests the existence of the class reorganization effect.

In 2000, we will incorporate group work, discussion and presentation for high ability students after the class reorganization.

References

[1] Gilster, P., "Digital literacy", John Wiley & Sons (1998).

[2] Higdon, J., "The evolution of computer literacy for preservice teachers", Proc. of 6th Int. Conf. of the Society for Information Technology and Teacher Education (1995).

[3] Keizer, J. and Wright, V., "Constructivism implementation in undergraduate computer application classes", Proc. of 8th Inf. Conf. of the Society for Information Technology and Teacher Education (1997).

[4] Mills, R., "Grouping students for instruction in middle schools", ERIC Digest, EDO-PS-98-4 (1998).

[5] Nakanishi, M. and Harada, A., "Reorganizing computer literacy classes in the middle of a term", Proc. of 7th Int. Conf. on Computers in Education, pp.507-514 (1999).

[6] Nakanishi, M. and Harada, A., "Ability grouping for teaching computer literacy classes", Proc. of ED-MEDIA, pp785-790 (2000).

[7] Raiford, P. and Braulick, L., "Computer literacy class for preservice teachers at university of Texas at Austin", Proc. of 6th Int. Conf. of the Society for Information Technology and Teacher Education (1995).

[8] Rogers, K.B., "The relationship of grouping practices to the education of the gifted and talented leaner", http://www.ucc.uconn.edu/~wwwgt/rogers.html (1999).

[9] Weinbrenner, S. and Devlin, B., "Cluster grouping of gifted students : How to provide full-time services on a part-time budget", http://www.kidsource.com/kidsource/content2/cluster-grouping.html (2000).

[10] Wiggins, G.P., "Assessing student performance: exploring the purpose and limits of testing", Jossey-Bass Publishers (1993).

Evaluation of the Web-Based Learning System "The Basic of Digital Media Communication "

Liu Huifen, Yu Lei, Liu Fang and Bao Su
Department of Communication, Tsinghua University, Beijing 100084,P.R.China
Tel: 86-10-62788647 Fax: 86-10-62785736
E-mail: liuhf@tsinghua.edu.cn

The web-based learning system "The Basic of Digital Media Communication" creates an interactive learning environment, which includes all the knowledge and aspects needed for the course. During the course, each student can choose freely either In Class Learning (ICL) or Web-Based Learning (WBL). Based on the questionnaires after the course, the paper evaluates the courseware system from the view of teaching and learning processes, interactive learning environments and learning effects. After the comparing study between ICL and WBL, it can be concluded that better computer and Internet environment can promote the students to accept the way of WBL, and WBL can enhance students' ability of self-study. Compared with ICL students, WBL students take less time and get higher score, and they are usually more efficient and individualized. The impact of traditional way of learning and interpersonal communication will exist for a long time, and there should be multi-way of learning to meet the different students.

Keywords: **Web-Based Learning, Evaluation, Interactive Learning Environments, Teaching and Learning Processes**

1 Introduction

The course, "The Basic of Digital Medial Communication", is a combination of computer application, communication and art design and it consists of basic theories, applications and creative design. That is, the basic knowledge of this course is about how to use the computer to organize, edit and deliver multimedia information. During the course, students need to do a lot of design works on computer. Because the content is so practical nowadays, the course is very popular among students. But since the course opened in 1996,it has confronted different problems concerning education mode and content. Firstly, the registration of the course is always limited by classroom and computer laboratory. Secondly, some of the reading materials were renewed and expanded nearly every year. Thirdly, because of the characteristics of the course, the most efficient way of learning and teaching is with the help of multimedia and network. Therefor, in the process of education reform, the course has experienced three ways of teaching and learning mode, that is, traditional learning, multimedia-assisted learning and Web-Based Learning. While improving the course gradually, a web-based courseware • The Basic of Digital Medial Communication• have been developed[1]. This courseware system constructs a comprehensive and interactive learning environment. The data capacity of the courseware is about 1 Gega Byte totally, and it includes all information and aspects needed for the course, such as the schedule, learning materials, experiment instruction, reference materials, demonstration and examples, answering questions, homework handed in and feedback, discussions and so on.

The object of the courseware is to construct a new learning mode, which should inspire the students' creativity and innovation. While instructed by teacher and assisted with modern education technologies, the students should be the center in the teaching and learning process. The course is carry on in an open and interactive environment, and the main features are as following:

(1) Open Computer Laboratories of the University are opened for the students, and they can visit the courseware at anywhere and on anytime if they logon to Internet. All the information about the course is published on the courseware, and the latest news or notice is always renewed according to teaching and learning process. The students can ask questions and discuss them with others through the courseware.

(2) According to the schedule, the students should finish a serial of media design work step by step. All the works can be handed in through web. Not long after hand in, each student can look up the web and get the score and comment from the teacher for each design work. The excellent works and the teacher' s comments will be published on the web on time, and the students can refer to and discuss about the works.

(3) In class lectures are based on the courseware, which will be projected on multimedia classroom. Discussing classes are arranged during the semester, which are also based on the courseware and projector. In this paper, we call this way of learning as In Class Learning (ICL).

(4) Except the ICL, the students can also choose the way of Web-Based Learning (WBL). In this way, the students need not attend the in class lectures, but they should finished all the design work and final test by self-leaning through the courseware system. The requirement of design work and final test are the same for both ICL and WBL students.

At first, the courseware system was used in a course composed of 30 students. Then, in the fall of 1999, it was used in a selective course opening to all the undergraduates and each student can freely choose the way of ICL or WBL, While the design work requirements and the test for both way are the same. At the end of the semester, two kinds of questionnaires were carried out among two group chose different learning modes. The questionnaires were designed in three aspects: the courseware system, the teaching and learning process and the learning effect. Compared and analyzed the feedback from the two groups, it can be concluded that, the web-based courseware system and learning mode have reached expected objects, and the learning effects have connection to the computer environment, the self-study ability of students and the impacts of traditional way of learning.

2 Web-Based Learning is the trend of modern education development

At the beginning of the semester, only 25% of the total 70 students chose the way of WBL. The others either chose ICL or couldn' t make their mind yet. After a period of time, when they got more familiar with the courseware system, all the students uncertain and 18% of those chose ICL originally turned to WBL. Consequently, the WBL students have made up of 61% of the total students registered. According to the investigation, the students' choice could be affected mainly by three factors, that is, self-study ability, computer and Internet environment and the basic knowledge for the course.

Among all the students, 72% of the juniors and seniors chose WBL, while only 46% of the freshmen and sophomores chose WBL. Those who chose the WBL consider it a better way, because the place, time and learning schedule can all been controlled freely by themselves. This in turn requires the students to be of higher ability of self-study. Most juniors and seniors prefer WBL, for they are usually better at self-study. From this point of view, higher ability of self-study is needed for WBL, and WBL will improve their ability of self-study, which is also the basic ability for life-long learning.

In order to visit the courseware without the limitation of time and space, Internet logon is the basic environment for the students. There are about 500 computers connected to Internet in the Open Laboratory of our University, but it' s always full of the students. More and more students have their own computers in dormitories, and more and more dormitories are connected to the Internet via high speed cable. From the investigation, most students chose WBL have better computer and Internet environment than those chose ICL. Therefor, the better the computer & Internet environment, the more the students who will accept WBL.

Because of the course' s feature, computer is both the tool and object of learning the course. Compared to ICL group, most WBL students consider they had basic idea about the course at the beginning of the semester. That means that WBL students have basic ability of computer application, which could been called as digital literacy and it' s the basic literacy demand in the information age [3]. So, the digital literacy is another factors that can affect their choices. In the process of WBL, computers and web are basic tools of learning, and it will definitely improve one' s ability for computer application or digital literacy.

3 Web-Based Learning is of more efficiency and individuality

WBL has more advantages over traditional way of learning. WBL has changed the traditional relationship between teacher and students, where the teacher is the initiative disseminator and the students are passive receivers. The courseware enables the students to study individually. They can decide how long to visit the courseware each time and which part to concentrate on. What' s more, they can do the homework or design work at the same time while reading the courseware, which is more efficient than traditional way of in class lecture and then design work.

Take the learning procedure of one chapter in the course for an example. In the teaching schedule, 6 in class hours are planed to finish the chapter and the relative design work. Analyzing the percentage of students and the total hours used to finish this chapter' s learning and design work (Fig 1), the statistic result shows that the hours used by WBL students tend to be more changeable. The average hours used by WBL and ICL are 6.5 and 8 hours respectively, while the average scores of this design work are 77.7 and 79.8 respectively. That is, WBL group turns to be take less average time and get higher marks.

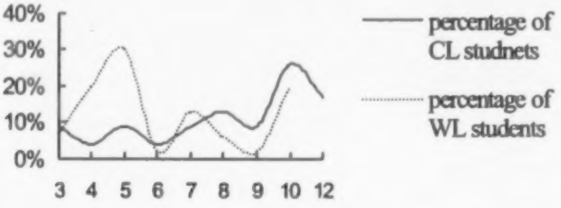


Fig 1: Percentage of students and the total hours used to learn chapter 7

Study the total time used for the course (Fig 2), it also shows that the ICL students tend to arrange their learning time according to teacher' s schedule, while WBL students tend to arrange their time individually. From the statistic of how WBL students read the courseware, only about 35% of them learn systematically and about 45% of them consult the courseware only if they need help. But WBL students' average total score is 84, higher than 80 of ICL students. Although scores are just one way to test the effect of learning, from all statistic results and analysis, it shows that WBL is of more efficiency and individuality.

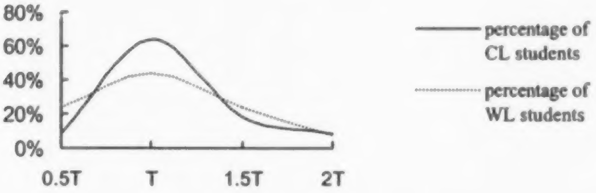


Fig 2: Percentage of students and the total time used for the course
(note: T is the total in class time of the course' s schedule)

4 The courseware system plays an important part in the learning process

The courseware is both the learning object and an effective learning tool, so it is very important in the learning process. At the beginning of the semester, teacher announces the schedule, homework requirement on the courseware. Then the Students can learn the knowledge from the courseware step by step according to the schedule, hand in their homework, ask questions and discuss relevant topics through the courseware. The answers to the common questions, the score and comment of everyone' s homework are also published on the courseware. The latest news on the courseware is renewed at least two times a week. Though parts of the learning materials are almost the same with the textbook, the courseware is more attractive because its multimedia, multiform and interaction.

The courseware is the main learning materials for the two groups, and more than one third of the students completed the learning only by the courseware. The top successful aspects of the course from the two group are showed in Table 1. When designing the courseware system, it was not expected that homework hand in and feedback by the courseware would be so popular among the students. The students whose excellent design work is published on the courseware are very proud about it, and the others would be greatly inspired and they will make their efforts to improve their own works too. So in the courseware, not only the database of learning material but also the interactive environment has played very important part in the teaching and learning process. Both WBL and ICL students evaluate the course highly, and the courseware system has reached its expected objects.

	ICL	WBL
1	Get the latest news from the courseware	Web-based learning
2	Homework hand in and feedback via the courseware	Homework hand in and feedback via the courseware
3	Discussing class by projector	Get the latest news from the courseware
4	In class lecture by projector	

Table 1: Statistic of the top successful aspects of the course

5 There should be multi-way of learning to meet the different students

At the end of the semester, most students feel satisfaction to the learning mode they chose, no matter WBL or ICL. Meanwhile, they all have good evaluations to self-study abilities. The two groups have different options about "discussing class". 68% of the ICL students think the discussion is indispensable and should be emphasized, for they can have chance to communicate with others in person, while 21% of the WBL students think it' s unnecessary, for they can "discuss" in the courseware. It' s clearly showed that, ICL students tend to be more rely on the interpersonal communication, while WBL students tend to be more rely on network communication. The weakening of interpersonal communication is a new problem emerging in the information age, and it will influence learning effect[4].

Analyzed which is "the best way of learning in college", 27% of all the students accept WBL completely, while 58% consider the best way is combining WBL and ICL, that is what we have done in the course. This kind of combination is suitable for students with different basis. For those tend to WBL, they can learn individually by the courseware system and consult the teacher in discussing class when they want. For those tend to ICL, they can get systematical instruction from the teacher in classroom, and use the courseware resource after class. In a long term, coexistence of multi-way of learning is a practical solution, which will instruct the learning and motivate creativity of students simultaneously.

6 Conclusion

Web-Based Learning has many advantages over traditional way, while it will take a long period of time for it to be perfected. Web-Based Learning has not only changed the teaching and learning process, but also the education mode and teaching thoughts. Its success depends on the network hardware, courseware and the efforts of the teacher and the students. In the course "The Basic of Digital Media Communication", the students are so eager for knowledge and so interesting in the educational reform. In fact, the courseware system is developed and improved during the teaching and learning process.

Web-Based Learning is the trend of education in today' s information age. This kind of learning is different from completely self-study. Though the interactive learning environments of the courseware system, the teacher instructs the students how to learn, and encourages them to study independently. Although the content is professional, the structure and learning mode of the courseware system have common sense for other courses. In order to satisfy different students and enhance their ability as well, the in class lectures will be decreased gradually, but discussing classes will be remained both for interpersonal communication and for answering the question face to face. In order to cultivate the higher qualified students in the information age, the education mode should stress the ability of acquiring knowledge and self-learning. This in turn, requires the teacher to be higher qualified too.

References:

[1] Courseware system "basic of digital media communication"• http://166.111.107.2/digit-media/index.htm

[2] Liu Huifen & Wang Yue• "The Design and Development of Web-Based Interactive Learning Courseware in High Education", Proceeding of ICCE '99, Advanced Research In Computers and Communications in Education , Vol 2, 1999, Japan.

[3] Liu Huifen, Zhang Xing & Wang Yong• "Education Structure and Method Study for Computer Mediated Communication" Proceeding of ICCE '98 ,Global Education On the Net, Vol. 3, 1998• Beijing.

[4] Liu Huifen• "The Impact of interpersonal communication in Distance learning" ,Proceeding of GCCCEY2K, May, 2000 Singapore

Everything in Moderation? Developing successful collaborative projects between European initial teacher education students

David Owen *, Brian Hudson*, Alison Hudson, Eila Jeronen***, Jan Morawski****, and Peter Schurz*******
**Pedagogy and New Technologies Research Group*
School of Education
Sheffield Hallam University
Sheffield S10 2BP
United Kingdom
Tel: +44 144 225 2448
Fax: +44 114 225 2324
D.H.Owen@shu.ac.uk *and* B.G.Hudson@shu.ac.uk
*** Centre for Multimedia in Education*
Learning and Teaching Institute
Sheffield Hallam University
Sheffield S10 2BP
United Kingdom
A.R.Hudson@shu.ac.uk
****Department of Teacher Education*
University of Oulu
P.O.B. 222
90571 Oulu
Finland
ejeronen@ktk.oulu.fi
*****Department of Education and Social Studies*
Hogskolan Darlana
S-781 88 Falun
Sweden
jmo@du.se
******Pädagogische Akademie des Bundes in Oberösterreich*
Kaplanhofstrasse 40
A-4020 Linz
Austria
schuerz@pa-linz.ac.at

Computer mediated collaborative projects have the potential to strengthen the European Dimension in teacher education whilst giving students an appropriate context to develop their computing and collaborative skills. This paper evaluates the success of such a project through the completion of a three-year action research enquiry involving student teachers from four European countries. The results of three cycles of development are presented. The project was evaluated using student questionnaire data, participation in tutor meetings, and analysis of students' web page development and bulletin board contributions. Results suggest that successful collaborative project work depends on ease of access to reliable computer networks, giving equal weighting to resource production and levels of international communication, and effective moderation of the project by all tutors involved. The paper concludes by detailing future developments in European cooperation involving the partner institutions. These developments involve using the Ecoschool communication networks to discuss pedagogic and multi-media design issues involved in a cross-curricular CD-ROM which has been developed by the same group of partner institutions.

Keywords: **computer mediated communication, European co-operation, moderation.**

1 Introduction

This paper reviews a three-year cycle of telematics curriculum development and action-research in initial teacher education. The project has been made possible by funding via the SOCRATES European Module ECOSCHOOL (1997-2000). The project has two aims; to develop learning by using the World Wide Web (WWW) and email across Europe, and to learn about the social and economic aspects of the participant' s home city. The outcomes of the project include the creation of a collaborative open learning course that teacher education students can follow as part of their training.

The Ecoschool developments originated from European collaboration on the EUROLAND project (1996-99). It brings together partners from Austria, England, Finland and the Netherlands in building the European Dimension into the curriculum of schools and teacher education courses (Hudson et al, 1997 and Hudson et al, 1999). Teacher education institutions and departments lead both projects in close collaboration with partner schools and teachers in each country. The resources that have been produced by both the Ecoschool and Euroland projects have been used as the basis for the development of pedagogic approaches with teachers on intensive in-service training courses, which have been supported under the Comenius 3.2 Action of SOCRATES.

The paper reports on four aspects of the Ecoschool project; the three year cycle of curriculum development, the tutor and student evaluation of the project, lessons learned regarding telematics pedagogy, and future developments that link the outcomes of the Euroland and Ecoschool projects.

1.1 Participants in the project

The participants are primary teacher education students from Linz and Sheffield together with students on an international teacher education course at Oulu. A more recent partner to this development is the University of Darlana in Sweden. This has led to the participation of a group of social studies student teachers from Falun in Sweden. English was used as the medium for communication and a total of eighty five students took part over the three years.

1.2 Collaboration and communication

A key aim of the project has been to promote the European Dimension and the use of Information and Communications Technology (ICT) in teacher education across Europe. The development of the European Dimension provides ample justification for collaborative communication but such projects can also reflect sound pedagogic principles. The pedagogical approach is based on a socio-cultural communicative perspective, which owes much to the works of Vygotsky (1987). Collaborative learning is at the heart of the Ecoschool project and has been used during the three cycles of student work. Many authors, including Hudson (1998) and English and Yazdani (1999) see such an approach as essential in developing students' learning skills when using ICT or learning without the aid of new technology.

2 Use of new technologies

The resources and tools being used are university email communications and the resources provided by the ProTo environment at the University of Oulu– *Project Learning Tools on the Web*. This is an open learning environment that has been developed at the University of Oulu. Students can access the ProTo system via the World Wide Web. They have a password that allows them to create simple web pages and enter messages on a bulletin board. Students also created web pages using Netscape Composer and posted them on their home pages. In cycle three they used an electronic bulletin board as well as using ProTo and email.

Use of such technology is now a key focus in the education of teachers across Europe. Student teachers in England and Wales follow the National Curriculum for Initial Teacher Training (DfEE 1998). This curriculum requires students to show evidence of using and creating multi-media presentations, and of using web technologies to communicate with colleagues. In addition, recently published guidance detailing an ICT primary school curriculum (QCA, 1998), suggests that children aged ten should be able to design and evaluate simple multi-media presentations, and children aged eight should be able to take part in an email exchange. Clearly student teachers need the confidence and skills to develop these abilities in their pupils. The Ecoschool gives students this experience through their participation in a computer mediated collaborative project and by their evaluation of its potential use in their future educational roles.

2.1 Pedagogic approaches

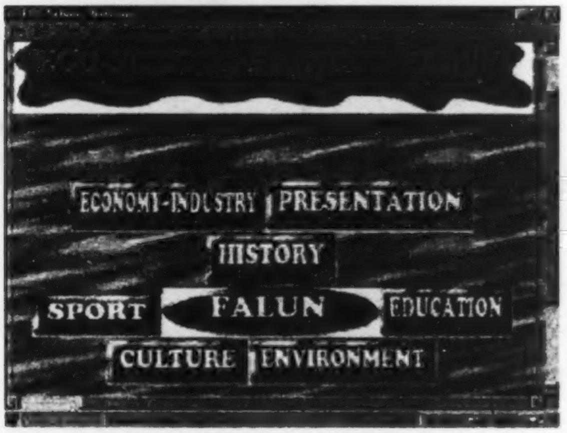
As previously stated the Ecoschool project uses a pedagogic approach that seeks to promote learning through 'electronic talk' in collaborative groups. These groups use a plan, do and review strategy as proposed by Kolb (1984) in his model of experiential education and by Schon (1987) describing the planning cycle used by reflective teachers and learners. The groups planned the construction of webpages, constructed and evaluated their own pages and those of other groups, then finally evaluated the whole project. Tutors developed their own pedagogy of distance learning during the project. The success of the tutors' approaches are analysed using guidance developed by McGee and Boyd (1995) to facilitate dialogue during computer mediated communication.

3 The three cycles of curriculum development

3.1 Cycle One

Focus : comparing students' home cities
Outcomes: web pages explaining local city

Figure 1: Work from the Swedish students posted to the ProTo learning environment.



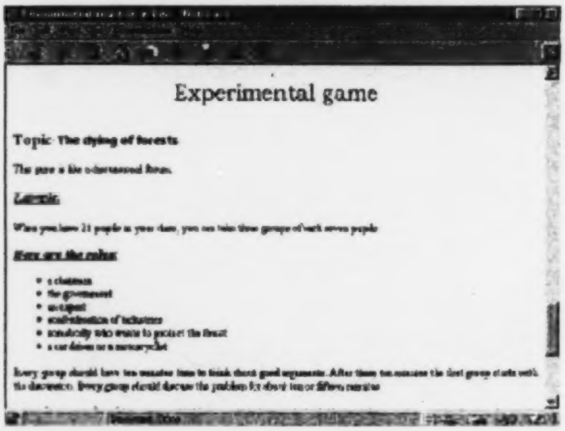
Students in each country worked in collaborative groups to produce a short illustrated report on one of the following aspects of their home city. This involved a general description of the city, an explanation of the environmental situation and the employment structure of the city, and an analysis of the regional or national education system.

Subsequently they presented these reports as web pages by writing them in to the ProTo learning environment. Figure 1 shows a page produced by the Swedish students. They also emailed their work to other students in the partner countries who were presenting the same topic. Once all web pages were complete, they read their partner's pages, asked questions and made comments about them on the bulletin board. Each group evaluated their work using the same criteria designed by the tutors in each country. The tutors then read each group's pages, assessed the pages and provided feedback to the each group. The students' work was assessed against the criteria and graded A to C. The tutors posted written feedback on the bulletin board.

3.2 Cycle Two

Focus : Comparing lesson planning
Outcomes: web pages giving examples of lesson plans

Figure 2: Teaching and learning about the environment in Lin



Experimental game

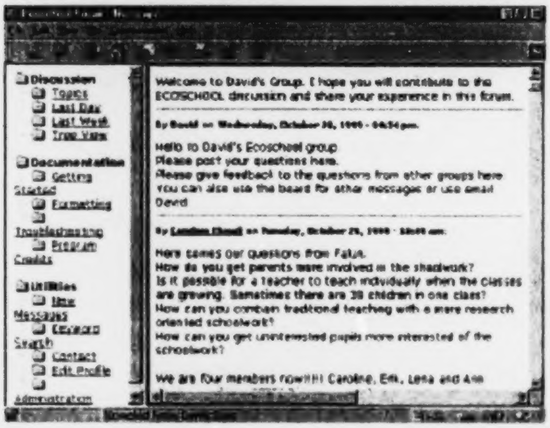
Topic: The dying of forests

The aim of this round of co-operation was for students to share lesson plans and teaching ideas. Each group of students planned lessons with the aim of children learning more about their local town or city. Again, students presented these as web pages on the ProTo system or, in the case of the Swedish students, on their university home pages. Each group of students again evaluated the pages of their partner groups, responded to each other's questions, and received feedback from the tutors in each country. Students' work was again assessed.

3.3 Cycle Three

Focus: suggesting and solving educational problems
Outcomes: range of solutions to five educational problems

Figure 3 The Euroland and Ecoschool discussion and chat site.



Welcome to David's Group. I hope you will contribute to the ECOSCHOOL discussion and share your experience in this forum.

Hello to David's Ecoschool group
Please post your questions here.
Please give feedback to the questions from other groups here
You can also use the board for other messages or use email
David

Here comes our questions from Falun.
How do you get parents more involved in the schoolwork?
Is it possible for a teacher to teach individually when the classes are growing. Sometimes there are 30 children in one class?
How can you combine traditional teaching with a more research oriented schoolwork?
How can you get uninterested pupils more interested of the schoolwork?

We are four members now!!!! Caroline, Erik, Lena and Ann

The Ecoschool project ran during autumn 1999 with several new developments. The students were in internationally composed groups rather than from one single country and the focus of the project was to choose an educational problem and present a solution to this by co-operating using ICT. The students could use email, create their own web pages, use ProTo2 (a more sophisticated version), or use the Ecoschool bulletin board (see Figure 3). The majority of students chose to use the bulletin board to present their problem and solutions although some students did use the ProTo2 learning environment. Again tutors gave feedback to the students and responded to their questions although the work was not graded.

4 Methods of curriculum development and evaluation

Ecoschool developments have followed an action research model, as the aim of the project was to develop a successful curriculum for initial teacher education over the three years of the project. The Ecoschool curriculum was developed in face-to-face planning meetings and followed up by email communication between partners in Austria, Finland, Sweden and England. The results of student and tutor evaluation were fed into the curriculum planning at the end of each cycle. The following methods have been employed in gathering evaluation data:

Student evaluation questionnaire. All students completed a questionnaire by email or on paper. Many groups posted the results of their evaluation on the ProTo system or on the Ecoschool bulletin board. The questionnaire requested information on student expectations of the project, levels of interaction, the role of the tutor, use of new technology and ideas for the future.

Tutor evaluation. A tutor from each country completed a written evaluation of their experience at the end of each cycle and presented the document for discussion at the annual Ecoschool development meetings.

Web page analysis. The students created web pages of differing levels of complexity during cycles one and two. The web pages construction process is evaluated against the six components of infomedia literacy as proposed by Lee (1999, pp.147-149). These components are:

1. An understanding of the nature and functions of infomedia and their impact on individuals and society.
2. The development of critical thinking ability.
3. The skill of efficient searching and critical selection of information.
4. Knowledge of multi-media production using appropriate technology.
5. Aesthetic appreciation of hypertext, graphic design and visual images.
6. Social participation in influencing the development of infomedia technology.

ProTo communication log analysis. The record of tutor and student communication during cycles one and two was analysed using Boyd and McGee's (1995) guidance on facilitating dialogues using computer-mediated communication. They suggest that facilitators provide both technical and content-specific support; are responsible for regularly communicating with the group; communicate in ways that require a response; and model standards of high quality interaction

Ecoschool bulletin board observation. The Ecoschool bulletin board was set up in September 1999 and provided the student groups with a shared electronic space for presenting and discussing their ideas. Each group had a separate area for their own use. The frequency and quality of communication was analysed as well as the level of interaction between group members.

5 Evaluation Results

Student evaluation questionnaire data was collected from 12 of the 16 student groups over the three years. The key points arising were:

- In cycles one and two students who were apprehensive about using the technology felt that had been successful and the majority of students found that resource production was enjoyable and had developed their ICT skills.
- Communication between groups was successful in cycles one and two but sporadic in cycle three. This was attributed to pressure of work from other areas of their degree (Oulu), lack of clarity in terms of the aims of the project and technological problems in Linz and Sheffield.
- In cycle three, two of the five groups were critical of the lack of commitment of their partners.
- Students in Sheffield requested formal computer sessions where they could meet and use university facilities for the project. All students felt that their tutors had supported them in cycles one and two, but three groups wanted clearer guidance in cycle three.
- By cycle three the students from Falun and Oulu requested the use of chat and video conferencing technology in any future work. Individual students in Linz and Sheffield experienced technical difficulties during November 1999 due to network problems at their institutions.

Minutes of three *Tutor evaluation* meetings and five written reports state that:

- The role of the tutor was clear in cycles one and two but not in cycle three
- Cycle three was seen as a radical departure from previous work and was viewed as 'experimental'
- Students in Linz, Oulu and Sheffield were hampered by block teaching practices taking place during key times in the project.
- Tutors were pleased with the progress made by their students in cycles one and two and had discussed how work in cycle three could be improved.

Web page analysis using Lee's concept of infomedia literacy reveals:

- Only two groups took a critical approach to the sources they used when constructing pages about their home city in cycle one.

- Three groups overtly discussed the problems of representing people and places on their web pages in cycle two.
- Four groups of students in cycle one saw the pages as similar to written text so did not exploit the advantages of hypertext fully.
- All students changed from passive users of web pages to active publishers of their own content.
- The students from Falun produced a website in cycle two that clearly demonstrated a collaborative approach and a high level of aesthetic appreciation in regard to page design.
- Students from Oulu and Falun were in general more adept at making critical comments about their own and other's work than the Linz and Sheffield students.

ProTo communication log and *Ecoschool bulletin board observation* using McGee and Young's guidance shows:

- In cycles one and two tutors adequately fulfilled the roles of moderator, mediator and facilitator.
- Tutors communicated with the participants by asking one or more questions, giving examples from their own experience to add to discussions and modelling high quality interaction.
- The cycle three work led to the production of questions and solutions but little discussion. In general tutors did not moderate the discussion effectively as they were unsure of their roles.
- The decision to limit the role of the tutor in cycle three had a negative effect on the level of interaction and quality of discussion. Student evaluations reveal uncertainty about technical issues as well as pleas for stronger leadership and rigid deadlines.

6 Discussion

The cycles of curriculum development and evaluation have identified many important features in the development of collaborative ICT projects. Establishing an international electronic community requires access to reliable technology for the students and also skill and commitment on the part of the tutors. Asynchronous communication is seen as one of the great advantages of electronic communication and university tutors may take their own ease of access for granted. In a study of barriers to student computer usage McMahon et al (1999) found that students identify real problems in accessing computers to complete course tasks. A Sheffield student reflects their conclusions when evaluating her experience in cycle three:

> *If we had been given time in our lectures to get together and a set routine with correspondence time every week then we would have got more out of it. As a group of people we are all in different (teaching) groups, so getting together is difficult and finding a PC when we have free time is also difficult.*

This highlights the question of computer access as well as the importance of study and group work skills in such a project. Very clear project goals and explicit expectations on student participation are also needed. Is it the students ' responsibility to meet and organise communication sessions during their own time, or will better levels of communication occur by booking computer access during student practical classes? If this is done are the benefits of asynchronous communication being demonstrated? An unexpected outcome of this project has been to highlight the importance of developing students' teamworking skills.

Once access is assured, the roles of the tutor as moderator, mediator and facilitator are crucial. A key finding from the evaluation is that communication was much more successful when the tutors had a strong moderating role in cycles one and two. When planning for cycle three, tutors limited the moderation role and gave the student groups much more independence. The majority of the students interpreted this as poor planning and one group described it as 'lack of leadership'. This highlights the complexity of the moderator's role and a recommendation from this project would be that the tutors spend time in the final evaluation meeting exploring their experiences in this role.

Developing a successful collaborative curriculum is dependent on creating a fine balance between resource production and communication. In cycle one the web pages produced were basic, but quality of interaction between students was high. In cycle two the web-based products were much more sophisticated but students paid less attention to communication, perhaps because more academic credit was gained for page development rather than communicating with fellow students. Student's work in the final cycle showed some evidence of sound international cooperation, but less in-depth critical analysis. Experiences gained during the three cycles have led to the development of a formal curriculum unit (see http://www.shu.ac.uk/schools/ed/teaching/dho/). Students will gain high grades only by giving equal weighting to communication, resource production and critical evaluation in their group work.

Finally, teacher education students need to transfer their learning to a classroom situation. One student has already set up a similar project whilst on teaching practice. In this example infant school children communicated via email with children in Bermuda and compared their localities, hobbies and homes as part of English and geography learning. Tutors need to set up opportunities for students to use their newfound confidence and skill in the classroom. Nook Lane Primary School in Sheffield is now linked with partner schools in Linz and Oulu as a result of the project, and students can now contribute to the development of this partnership.

6.1 Future developments

As a result of ongoing evaluation the following developments have been planned for 2000-2001. A chat facility had been added to the Euroland/Ecoschool discussion area in addition to the bulletin boards. Building on the success of a trial video-conferencing session held in November 1999, students will be able to use this form of communication from September 2000 in all countries. Students and teachers can also now access the communication tools via the Hallam Geography Education web site as well as from the Euroland web pages. Finally, with the imminent completion of the Euroland CD-ROM, the two projects will be brought together. Students and teachers will be able to use the CD-ROM as a focus for collaboration and discussion in the areas of infomedia literacy and multi-media development, the pedagogy of computer-mediated collaboration and the comparison of European social and environmental learning.

7 Conclusion

The Euroland and Ecoschool projects represent successful examples of how an international perspective can be developed in the university and school curricula. Sustained and effective communication is the key to such initiatives, alongside ease of access to computing facilities and a focus on the crucial role of the tutor as moderator. Both projects have provided tutors, students and pupils with membership of an expanding European network, which is a solid platform for the development of further collaborative work.

8 References

DfEE (1998) High Status: High Standards Circular 4/98. HMSO.

English, S and Yazdani, M. (1999) Computer-supported co-operative learning in a Virtual University. *Journal of Computer Assisted Learning*, 15, 2-13.

Hudson, B. (1998) A social perspective on learning in the context of Computer Mediated Communication in teacher education. *Proceedings of ICCE 98: International Conference on Computers in Education,* Beijing, China, 14-17 October 1998, 627 – 632.

Hudson, B., Hudson, A. & Schürz, P. (1997), Euroland: A Collaborative European Cross-Curricular Project using CD-ROM. *Proceedings of ICCE 97: International Conference on Computers in Education,* Kuching, Sarawak, Malaysia, December 1997, 1006-1007.

Hudson, B., Schürz, P. and Hudson, A. (1999), The Euroland/Ecoschool projects: Promoting Collaboration in a European context using CD-ROM and the WWW, Paper to Subnetwork D: Powerful Learning Environments in Teacher Education. *Conference of the Thematic Network on Teacher Education in Europe (TNTEE)*, Lisbon, 1999, http://tntee.umu.se/lisboa/

Kolb, D.A. (1984) *Experiential Education: Experience as the source of learning and development.* Prentice-Hall.

Lee, A.Y.L (1999) Infomedia Literacy: An educational basic for young people in the new information age. *Information, Communication and Society* , 2, 2, 134-155.

McGee, P.A. and Boyd, V (1995) *Computer-Mediated Communication: Facilitating Dialogues* at http://www.coe.uh.edu/insite/elec_pub/html1995/173.htm . Visited 4/10/00.

McMahon, J. , Gardner J., Gray, C., and Mulhern. G. (1999) Barriers to student computer usage: staff and student perceptions. *Journal of Computer Assisted Learning*, 15, 302-311.

Schon, D.A. (1987) *Educating the Reflective Practitioner: towards a new design for teaching and learning in the professions.* Jossey-Bass.

QCA (1998) Information *and Communications Technology: A Scheme of Work for KS1and KS2*. QCA.
Vygotsky, L.S. (1987) *The Collected Works of L.S. Vygotsky*, Vol.1 Plenum Press, NY.

http://www.shu.ac.uk/services/lc/cmeweb/Euroland/chatgroups.htm
The Euroland and Ecoschool discussion and chat fora.
http://ProTo.oulu.fi/
The ProTo open learning environment.
http://www.du.se/~lmh98lae/
Ecoschool pages created by students form Falun, Sweden.
http://wwwedu.oulu.fi/homepage/ejeronen/eco/index.htm
All cycle one and cycle two work can be viewed at this location.

Explorers or Persisters? Evaluating Children Interacting, Collaborating and Learning with Computers

ROSEMARY LUCKIN AND BENEDICT DU BOULAY,
School of Cognitive & Computing Sciences
University of Sussex
Brighton BN1 9QH UK.
E-mail: *rosel@cogs.susx.ac.uk* and *bend@cogs.susx.ac.uk*.

In this paper we discuss our observations of a group of 10 and 11 year old children using an Interactive Learning Environment called the Ecolab. The design of this software was informed by our interpretation of Vygotsky s Zone of Proximal Development in which *Interaction* and *Collaboration* are definitive characteristics. The relationship between the differences in interaction/collaboration style and the learning gains made by the children are discussed. The results show that children can be grouped into profiles according to the differences and similarities in their use of the system and that common interaction features are influenced by the design of the software being used. We suggest that children are poor at managing their own learning experience with technology even when the software offers both opportunities to complete challenging activities and support to ensure success. The children in this study needed explicit direction towards activities which were beyond their ability. However, caution with regard to this provision of *direction* is important to ensure that the child is also offered opportunities for creativity: a suggestion from the system about what and how to proceed is often sufficient.

Keywords: **Interaction, Collaboration, ZPD, ILE.**

1 Introduction

Computers are now an accepted part of classroom life for most young learners whether they are used for communication, visualization, simulation experience or simply for fun. But how do children actually interact with computers? Does the nature of their interactions vary from child to child in a way that could inform the design of the software which engenders these interactions? This paper explores children s use of an Interactive Learning Environment (ILE) called the Ecolab which was designed to help children learn about ecology. The system attempts to fulfill the role of a more able learning partner for the child and invites collaborative interaction. The collaboration is thus between the system and the child and not between children. Here we describe the nature of the interactions that a class of children had with this system. The nature of these interactions is considered in the light of pre- and post-test learning gains to explore the relationship between learning and interaction style. The Ecolab software has been designed using a framework derived from our interpretations of the Zone of Proximal Development (ZPD) [10, 11]. The ZPD describes the most fertile interactions which occur between the more and less able members of an educational culture and focuses attention on how the more able can help learners to learn. The ZPD offers a theory of instruction which emphasizes the inseparability of the teaching and learning processes and thus recognizes the inherent interactivity of children s learning with computer software. It also stresses the need for learners to have the help of a collaborative learning partner in the form of a peer, a teacher or in the case of the Ecolab, a computer. Within a Vygotskian, socio-cultural model of education human activity is mediated by tools and sign systems that have arisen through social interaction. Developmental explanations are used to address the complex internalisation process by which the interpsychological relations between partners in social interaction becomes intrapsychological within the individual learner. Interaction and Collaboration are therefore definitive characteristics of the ZPD which form the linchpin of the socio-cultural framework and thus form the focus of our investigations of children using the software.

In this paper we provide a brief description of the Ecolab software before discussing an evaluation study of its use. We report the results with particular emphasis upon the nature of the Interaction and Collaboration profiles we were able to construct from our records of system use. We provide examples of individual learner s use of the system and discuss the relationship between the nature of the interactions and the learning gains recorded after system use.

2 Ecolab Software

Ecology is a subject that involves the study of relationships between organisms within our environment. These relationships can be extremely complex; they can also be introduced in a simplified manner through concepts such as food chains and food webs. These form the foundations of more complex ecosystems and are part of the curriculum for primary school children in the United Kingdom. The Ecolab software provides 10 and 11 year old children with the facilities to build, activate and observe the ecological relationships which exist between members of a simple food web in a woodland ecosystem. It provides a simulated ecology laboratory environment into which the child places the animals and plants of her choice. This environment can be viewed by the child from several different perspectives or *views*, including:

World - a picture of a woodland environment and the organisms the child has chosen to place within it.
Web - a traditional text book style diagram of the organisms in a food chain and food web.
Energy - a graphical representation of the energy levels of the organisms currently alive in the Ecolab.
History - a linear narrative of what has happened in the Ecolab world to date, which animal has eaten which other animal for example.

As we have already stated the nature of the relationships that can exist between organisms in the real world can be very complex. We wished to allow each of the children using our system to learn about relationships at a level of complexity that was appropriate to them. We therefore built the learning environment in a manner that would allow children to learn about relationships ranging from the simplest, between just two single organisms, to the much more complex network of relationships that could exist in a very simple ecosystem involving populations of organisms. The complexity of the relationships represented within the Ecolab can be varied at any stage during the child's interaction with it. It is also possible to alter the abstractness of the terminology used to describe the organisms in the Ecolab so that a snail, for example, can be described by the words "herbivore", "primary consumer", or "consumer" as well as the word "snail".

In addition to this simulated laboratory environment, the system acts as a collaborative learning partner for each learner which can provide assistance of the following sorts:

Extension of the learner s knowledge through increasing the complexity of the relationships she is asked to study and/or the abstractness of the terminology used to describe what is happening in the Ecolab.

Collaborative Support which can take the shape of *Activity Differentiation:* in the form of alterations to the difficulty of the activities the learner is asked to complete, or context sensitive *Help* of variable levels of quality and quantity.

At the start of this paper we discussed our use of the Zone of Proximal Development to underpin our system design and the importance of *Interaction* and *Collaboration*. In order to explore the nature of the interactions children had with our software, the collaboration that might occur between system and learner, and the relationship between interaction, collaboration and the changes in learning outcome recorded after system use, we varied the manner in which collaboration from the system was offered to the learner. The Ecolab consists of three system variations: VIS (Vygotskian Inspired System), WIS (Woodsian Inspired System) and NIS (Non-theoretically Inspired System). These three system manipulations implement different design elements in order to adjust the assistance they provide (see [4] and [5] for more detail). The way in which each of the system variations adopts a different approach is summarised in Table 1. In particular, VIS makes more decisions than WIS which makes more decisions than NIS. In other words NIS gives the learner most freedom of choice to the learner and VIS the least.

3 Interactions with the Ecolab

An exploratory evaluation of the Ecolab software was conducted with a class of children aged 10 and 11 years. We wanted to investigate the extent to which the system would be able to adjust to learners of differing abilities, and also the ways in which the interactions and collaborations between user and system varied with users of different abilities. The children's school assessments were therefore used to allocate each child to one of three ability grouping: High, Average and Low. Prior to using the software each child completed a written and a verbal pre-test, the latter of which was in the form of a structured interview recorded on audio tape. Each child used the Ecolab software as an individual for a total of 60 minutes over two sessions. In addition, a 20 minute initial session with a smaller 'demo' versionensured that all children were comfortable with the mouse skills required and the interface. After the system intervention subjects were given a written and verbal test, identical to the pre-test, and a short additional extension interview. A delayed post-test was conducted 10 weeks after the end of the original post-test. Of the 30 children who started the study only 26 completed all sessions between, and including, pre and post-test. The four who did not complete these sessions had either left the school or been absent during the evaluation period. Only 24 completed all sessions including the delayed post-test. Once again the reason for non-completion was absence from school.

Table 1 Collaborative Support within Ecolab

Collaborative Support within Ecolab			
	VIS	WIS	NIS
Levels of Help Available (different levels provide differing qualities of help - 5 represents the greatest and 1 the least)	5	5	2
Decision about Level of Help made by	system	system and child	child
Levels of *Activity Differentiation* Available	3	3	3
Decision about type of Activity and Differentiation level made by	system	child - system makes suggestions	child
Extent of Learner Model maintained by the system and used to make decisions about the support to be offered to the learner.	Bayesian Belief Network (BBN) of values representing the system's beliefs about child's ZPD formed from its knowledge about the amount of collaborative support used to date.	Record of help used to enable contingent calculation of next help level. Record of curriculum nodes visited maintained to permit suggestions.	Record of Curriculum nodes visited maintained to help child keep track.
Abstractness of Terminology selected by	system	child	child
Area of the Curriculum and complexity of the next activity selected by	system	child - system makes suggestions	child
Ecolab View selected by	mostly child	child	child

The results of the pre- and post-test were used to assess the efficacy of the three variations of the Ecolab software. This work is reported elsewhere [4, 5] and is not the main focus of the current paper. It is the character of the interactions between each child and the system that we will focus upon here. We wanted to investigate what sorts of interactions had resulted in the greater learning gains and which systems had supported and encouraged various types of interaction and collaboration in order to inform the design of our next system. For each child a summary record of their interactions was produced from the detailed logs maintained during their two sessions of system use and this was used to build up a picture of the types of interactions each child experienced with the system (for full information see [4]).

Cognitive or learning styles have been a subject of active interest in recent years [1, 3, 6, 8], for a brief review see [9]. The influence which a learner's style can have upon the way they interact with technology has also been recognised [7]. Within this literature there are examples of classification systems which differentiate learners according to their learning preferences; for example, as serialists or holists [6]. The analysis of the annotated interaction summaries of children's experiences with the Ecolab software takes a fresh perspective on classification using only the styles of interaction or *Profiles* which can be found in the records of each child's system use and emphasizing our interest in the nature of *Interaction* and *Collaboration*. Characteristics were identified and children categorised through:

- **Interaction Profiles** according to the character of their interactions with the Ecolab.
- **Collaboration Profiles** according to the nature of the collaborative support provided by the system for the child.

4 Results

One aspect of the evaluation looked at whether the different variations of the Ecolab had been more or less effective in increasing the child's learning gain in terms of her understanding of the feeding relationships which exist in a food web as reflected in the pre- and post-test data. This indicated that the system variation (VIS, WIS or NIS) which the child used was relevant to her subsequent learning gain and a detailed discussion of these results can be found in [5]. Here we wish to concentrate upon the analysis of the records of interaction which was used to try and pinpoint the elements of VIS and WIS which led to their superior performance with particular ability groups.

4.1 Interaction profiles.

There were two characteristics which could clearly be seen as either present, or largely absent within the children s interactions. These were referred to as:

- **Busyness** and
- **Exploration**

Busyness was considered to be a characteristic of interactions in which the children completed an average or above average number of actions of any type, such as adding an organism to their Ecolab world or making one organism eat another. The interaction summaries of these children contained an above average number of events. The opposite of Busyness is referred to as **Quietness**.

Exploration was considered to be a characteristic of an interaction if the child had been involved in some sort of action which allowed her to experience more than one level of complexity or more than one level of terminology abstraction, beyond her initial starting levels. The opposite of Exploration is referred to as **Consolidation**.

Some children also switched frequently from one type of interaction to another. For example, they might switch from attempting to make one animal eat another, to looking at their organisms in a different view (i.e. perspective), to accessing a new activity entirely. Their interactions contained no or few series of repeated actions of the same type. They were particularly prone to frequent changes of view. These users have been characterised as **hoppers**. Other learners exhibited a more persistent approach, with sets of actions of a similar type grouped together. These users have been referred to as **persisters**.

These characteristics allow the children to be categorised , in principle, into 1 of 8 (2x2x2) possible Interaction Profiles.

The three parameters of categorisation: Busy/Quiet, Exploration/Consolidation and Hopper/Persister bear some similarity to features found in other categorisation systems. Pask's [6] differentiation of tendencies in learners towards being either "top-down" holists or being "bottom-up" serialists shares some common ground with the Hopper/Persister characteristic, for example. The differentiation of exploration from continuing activity at a level of consolidation is likewise similar to the challenge/safety division of [2]. However, the motivation for the analysis reported in this paper was not the presentation of a generally applicable categorisation system. The aim was twofold:

- To investigate the relationship between interaction style and learning gain.
- To examine how each of the system variations (VIS, WIS and NIS) of the Ecolab supported and encouraged particular learning styles.

Children fell into 6 of the 8 possible Interaction Profile groups. The distribution within these groups is illustrated in Table 2.

Table 2 Interaction Profile Membership

Profile Description	% of children in Profile group
Busy - Exploring - Persister (BEP)	28%
Busy - Exploring - Hopper (BEH)	12%
Busy - Consolidating - Persister (BCP)	8%
Busy - Consolidating - Hopper (BCH)	12%
Quiet - Consolidating - Persister (QCP)	20%
Quiet - Exploring - Persister (QEP)	20%

4.1.1 Examples of User Interaction Profiles

S10 (Gene) was a typical example of the *Busy - Exploring - Persister* style of interacter. Her first action was to switch from world view to energy view and then back to world view. She then added 15 organisms to the Ecolab and visited energy view again. Upon switching back to world view she made one of her organisms eat another, switching to energy view to see the effect. This pattern of making organisms act, either eating or moving and looking at the effect in an increasing number of different views continued. Introductory, investigative and rule-definition activity types were completed for the first two nodes in the curriculum before her first session drew to a close. She chose not to save her current Ecolab world which meant that at the start of her next session her first actions were the addition of organisms. Once again she added all 15 and then moved into the next phase of food web complexity and used more abstract terminology to view her organisms. Whilst the nature of the actions she completed was now more advanced and several instances of help were used, her pattern of activity remained one of initiating an action or actions appropriate to the evident goal. Actions were often completed in pairs and were followed by viewing the result from different perspectives (most commonly, energy, web and world). She did not experiment with writing a program or attempt to escape from completing the activities offered to her.

This profile group contains only high and average ability children from the VIS and WIS system user groups. In terms of performance at post-test there was a tremendous spread: A *Busy - Exploring - Persister* style learner attained the lowest learning gain, another, the second highest learning gain. The high ability children within the group all achieved an above average learning gain, but within the average ability children there was a wider spread of learning gain scores. Membership of this group was limited to VIS and WIS users, of whom the VIS users all achieved above average post-test learning gains, including the highest learning gain within this user group.

4.2 Collaboration profiles.

Two characteristics were found to be the most useful for differentiating collaborative style within the interactions: Amount of support and Depth of support used. These collaboration characteristics were used to group the children into one of four Collaboration Profile groups.

Amount of support: the average amount of activity differentiation (i.e. the degree to which the activity is presented in a simpler form) and the average number of help instances for the experimental group was calculated. An above average amount of either activity differentiation or instances of help was the criteria necessary for a child to be considered as using 'Lots' of collaborative support.

Depth of support: this characteristic was based upon the level of help and level of differentiation used. Once again the average levels used within the experimental group were calculated. Help or differentiation above the average level resulted in a child being considered as using 'Deep' or higher level support.

Interactions could be grouped into all 4 of the possible Collaboration Profiles. The first group was the largest and was further divided in accordance with the type of support which was most prevalent. The distribution of children into these groups is illustrated in Table 3.

Table 3 Distribution of children within Collaboration Profile groups

Profile Description	% of children in Profile	Profile sub-group Description	% of children in Profile sub-group
Lots and Deep (LD)	53%	Differentiation and Help	19%
		Differentiation	19%
		Help	15%
Lots and Shallow (LND)	12%		
Little and Deep (NLD)	16%		
Little and Shallow (NLND)	19%		

4.2.1 Examples of User Collaboration Profiles

S1 (Jason's) use of the available support was typical of the *Lots and Deep* profile group and of a user of above average amounts of both help and activity differentiation. He used level 4 help early in his first session of system use to achieve success in making organisms eat each other. His initial activities were completed with maximum differentiation of level 3. This was gradually reduced and then increased again. During his first session of system use he completed a range of activities for three nodes in the first phase of the curriculum. All instances of successful help were at level 4 or level 5. Fewer activities were completed during his second session. However, these activities were at a lower level of differentiation and there were fewer instances of help.

This Collaboration Profile group was the largest and was subdivided to account for the type of support used. Only VIS and WIS system users shared the profile. Jason was a member of the subgroup which used above average amounts and levels of both activity differentiation and help. This subgroup again consisted only of high and average ability children whose mean learning gain is above the average for the whole class (16% as compared to the class average of 11.5%). The subgroup of children who used greater levels of differentiation than help contained children from all ability groups. This second subgroup also produced above average learning gains at post-test (18% as compared to the class average of 11.5%). The last subgroup of children, who used greater amounts of help than differentiation, were all average ability children. Their average learning gain was well below the class average (3.9% as compared to the class average of 11.5%).

System variation had a greater impact upon the nature of the Interaction and Collaboration profiles than ability. A Pearson Chi-squared statistical test was also used to assess the relationship between the Ability groups, System Variation Groups, Interaction Profile Groups and the Collaboration Profile Groups. There was a significant association between System variation membership and Collaboration Profile membership ($X^2 = 28.52$, df = 6, $p < .0001$), and also between System variation membership and Interaction Profile membership ($X^2 = 25.79$, df = 10, $p < .01$).

So far little has been said about the NIS user group, they have not belonged to either of the Profiles used in the examples. In fact, all the NIS users belonged to a Consolidating Interaction profile; there were no explorers in this system user group. In addition, and as has previously been mentioned, no NIS users were in the Lots and Deep Collaboration profile group.

S9's (Tim's) Interaction profile which was that of a Quiet, Consolidating Persister, was typicalof a NIS system user. His initial session consisted of adding a single snail and then making 11 view changes to look at this organism from all perspectives. This initial stage was followed by a series of organism additions (commonly in blocks of 4); single actions, such as move or eat commands, in blocks of 1 to 5; and view changes which were almost always in pairs. In session 2 he adopted the commonly seen approach of adding a considerable number of organisms to start (in this case 12) and then once again completing single actions and view changes.

Likewise S26 (Karlie)s Collaboration profile reflecting low use of all types of help (Little and Shallow: NLND) was typical. She placed herself at the far extreme of food web complexity and started dealing with populations of organisms straight away. She only completed one type of action during both sessions of computer use: she built food webs using the *build web* command. Initially she made errors and used only occasional low level feedback, persisting until successful. The children in this profile group were all of high or average ability, but their average learning gains were well below average (5.2% as compared to the class average of 11.5%)

A further difference found within the NIS user group relates to the relationship between ability and learning gain. In the VIS and WIS user groups it was the higher ability children who achieved the greatest learning gains. By contrast, amongst the NIS users none of the high ability children made an above average learning gain, in fact the only learners who made above average learning gains were the low ability children. Whilst the numbers are small and the study exploratory this result is interesting and is certainly informing our current research. We had expected that of all three systems, the one which left most control within the hands of the learner would be most effective with the more able learners. Our results indicate that the opposite was in fact the case in our study.

5 Conclusions

This is an initial exploratory study with small numbers of children. However, there are several observations which are informative in building up a picture of the sorts of interactions which children experienced with the version of the system they used. VIS was the system which explicitly selected the next curriculum area for the child to complete and controlled the complexity and abstractness of the learning environment. Not surprisingly, all VIS users were members of profile groups with the 'Exploring' characteristic present. The split between 'Busy' and 'Quiet' was almost even. Only two of the VIS users scored a below averagdearning gain at post-test and both were in the same 'Quiet, Exploring, Persister' profile group. The majority ofWIS users were also 'Exploring' profile group members and only one did not belong to a 'Busy' profile group.However, whilst all the WIS above average learning gain achievers were members of 'Exploring' profile groups, the below average achievers were all members of different profile groups, with no common features between all of them. The WIS system variation did not set the curriculum area for the users, but did make suggestions which resulted in it being easier for a WIS user to avoid being an 'Explorer' thana VIS user. The NIS users were the children with the greatest freedom and the least finely tuned help system. It is perhaps not surprising therefore that none of them belonged to a profile group with the 'Exploring' characteristic. They were evenly split between being 'Busy' and 'Quiet' and the majority were 'Persisters'. Only two NIS users achieveabove average learning gains and unlike the WIS and VIS users, both were in profile groups which shared the 'Comfortable' characteristic, they were also both in the low ability group.

These results suggest that simply providing children with the means for extension through becoming involved in challenging activities is not enough to ensure that these challenging activities are undertaken. The child needs also to be explicitly directed towards activities which are beyond her ability. However, caution with regard to this provision of *direction* is important to ensure that the child is also offered opportunities for creativity. The success of WIS indicates that a suggestion about what and how to proceed is often sufficient. The consistency within the high and average ability groups across the different systems for above average learning gain achievement to be linked to the 'Exploring' profile characteristic isnot reflected in the low ability group. The definition of the 'Exploring' characteristic may of coursebe too crude to encompass the possibility that the low ability children were 'Exploring' within interactions in a single phase of the Ecolab.

The manner in which each variation of the system collaborates with the child is a design feature of that variation and as such a big influence upon the resultant user Collaboration Profile. It was no surprise, therefore, that there was a significant association between system variation and collaborative support profile membership. However, it is possible, in principle, for a user of any of the variations to interact in line with any of the Collaboration Profiles described. In reality Collaboration Profile 'Lots and Deep' was exclusive to VIS and WIS users, whereas Collaboration Profiles 'Lots and Shallow' and 'Little and Deep' were exclusive to WIS and NIS users. The only system which allocated both help and differentiation to users was VIS, so the fact that VIS users all used a high quantity and quality of help is unsurprising. WIS users often used a high level of assistance too, but in smaller quantities, they all belong to profiles where the support used was of a high level. In contrast, all NIS users are in profile groups in which the level of support is low. The choice of help

BEST COPY AVAILABLE

available to NIS users was admittedly more limited being of only two levels, however none of the users ever chose to use the higher level of help offered.

The absence of some forms of assistance from the interaction summaries of the less successful users offers support for the suggestion that it is the combination of being challenged, or extended, plus the provision of ample quantities and qualities of support which is important for learning. The lower ability children present a somewhat different picture as there is no apparent consistency between the use of collaborative support and learning gain. The only tentative conclusions are that this group responded to interactions in which the extent of the challenge was limited and that the nature of the assistance the system could offer was not effective for them. Those who were successful took up less different types of assistance and tackled less of the curriculum than their successful more able peers. There is also evidence that these children were not good at managing their own learning. The NIS Interaction and Collaboration profiles in particular would suggest that children who are given control for their own learning experience are not good at setting themselves challenging tasks or indeed seeking collaborative support. Our current work with children is investigating this issue in more depth.

Acknowledgments

This research was sponsored by the Economic and Social Research Council. Thanks are also due to David Wood and Yvonne Rogers for useful discussion and insightful comment upon this work, and to the children and teachers of Blacklands School, Hastings for being enthusiastic participants in the evaluation study.

References

[1] Goodyear, P. Njoo, M., Hijne, H. and van Berkum, J. J. A., Learning processes, learner attributes and simulations , *Education and Computing*, Vol. 6, No (3/4), pp. 263-304, (1991).

[2] Groat, A. &. Musson, T., Learning styles: individualising computer-based learning environments , *Association for Learning Technology Journal*, Vol. 3, No. 2, pp. 53-62, (1995).

[3] Kolb, D. A., *Experiential learning: Experience as the source of learning and development* , Englewood Cliffs, NJ: Prentice-Hall, (1984).

[4] Luckin, R., *Ecolab: Explorations in the Zone of Proximal Development* , (CSRP No. 486). School of Cognitive and Computing Sciences, University of Sussex, (1998).

[5] Luckin, R. & du Boulay, J.B.H., Ecolab: The Development and Evaluation of a Vygotskian Design Framework , *International Journal of Artificial Intelligence and Education*, Vol.10, No. 2, pp. 198-220, (1999).

[6] Pask, G., Styles and strategies of learning , *British Journal of Educational Psychology*, Vol. *46*, pp. 128-148, (1976).

[7] Riding, R. &. Rayner., S., The information superhighway and individualised learning , *Educational Psychology*, Vol. 15, No. 4, pp. 365-378, (1995).

[8] Riding, R. &. Read, G., Cognitive style and pupil learning preferences , *Educational Psychology*, Vol. 16, No. 1, pp. 81-106, (1996).

[9] Valley, K., Learning styles and courseware design , *Association for Learning Technologies Journal*, Vol. 5, No. 2, pp. 42-51, (1997).

[10] Vygotsky, L. S., *Mind in society: the development of higher psychological processes* , (M. Cole, V. John-Steiner, S. Scribner, E. Souberman, Trans.). Cambridge, MA: Harvard University Press, (1978).

[11] Vygotsky, L. S., *Thought and language* , Cambridge, MA:MIT Press, (1986).

Implementation of an Internal Execution Simulator and its Application to Computer Literacy Education

Takako SHIMIZU* Mario NAKAMORI and Kanji AKAHORI*****
**Graduate School of Engineering, Tokyo University of Agriculture & Technology,
2-24-16,Nakacho, Koganei, Tokyo, 184-8588,
Japan,E-mail:tshimizu@al.ei.tuat.ac.jp*
***Faculty of Technology, Tokyo University of Agriculture & Technology,
2-24-16,Nakacho, Koganei, Tokyo, 184-8588,Japan,E-mail:nakamori@cc.tuat.ac.jp*
****The Center for R & D of Educational Technology,Tokyo Institute of Technology,
2-12-1,Ookayama, Meguro-ku, Tokyo, 152-8552,Japan, E-mail:
akahori@cradle.titech.ac.jp*

Today, computer literacy courses in general education are common in Japanese universities. Usually, such courses include word processing and spread sheet calculation, in which the control operation is given by clicking a mouse cursor on a computer display. Students tend to pay attention only to the mouse and the display, which are situated at the most external level of the computer. Thus, it is very difficult for many students to understand what is going on in the internal level of the computer and the present status of learning. The above point of view has led us to the following hypothesis: Observing the movement of data and control of the operating system in the internal level helps students understand the essence, which will be a basis of their further studies on computers. We have designed and implemented two kinds of computer simulators: (1) The one that visualizes the internal execution of a computer, and (2) the one that does not visualize the internal execution. We made experimental uses of both simulators in an actual course and compared the two results. We concluded that the simulator visualizing internal execution has a better effect. Furthermore, we obtained the following result: Presenting the movement of the data and control of the operating system helps students understand the computer operation.

Keywords: **computer literacy, internal execution, computer operation, visualization**

1 Introduction

As the availability of computers increase, more computer literacy education is widely offered at universities, including those departments affiliated with the liberal arts. The instruction offered usually includes how to use word processors, spreadsheets, and how to access the Internet. The operating system used in most cases is Microsoft Windows and the most commonly used input device is a mouse.

It is often observed that students have a perfunctory and vague attitude when responding to their manipulation of fragmentary data appearing on the screen with a mouse. However, if students are able to comprehend what is taking place inside the computer and also have a general idea of the state of the OS (operating system) at each moment, they will be able to understand the fundamentals of the computer operation. This, in turn, would make subsequent learning easier. In other words, the potential of further understanding the computer is limited when only superficial operating procedures are learnt. Therefore, we hypothesized that visualizing the computer's internal operations would contribute to the student's higher understanding of the process, such as how a file is moved to a storage location by the current manipulation, which is one step beyond the computer display. In "The Report on General Information Processing

Education"(1) published by the Information Processing Society of Japan, the importance of computer literacy education is mentioned. However, many universities are struggling to come up with effective teaching methods. (2),(3)

In the past, there were researches done (4),(5) in education that used computers to simulate the computer itself, for example. Further researches on dynamically visualizing the contents of learning include an algorithm animation (6),(7),(8),(9),(10), a program execution and visualization of calculation operations (11),(12),and visualization of OS (13),(14). Most of these researches are concerned with students of computer science, whereas this paper takes up an internal simulation of Windows OS, which is frequently used in the general computer literacy education including that offered to liberal arts students. In this study, a system was developed that simulates computer operations that goes one step deeper than the normal computer "exterior". The authors then carried out an experiment using the system to a group of liberal arts students and evaluated it.

The purpose of this study is to increase the learner's understanding and subsequent learning by providing visualization of the permanent storage, file movement, and the change in OS controls within the computer.

2 Development of the Simulator

2.1 Structure of the Simulator

The computer system used in the simulator includes a computer, display, keyboard, printer, and a floppy disk. Two locations inside the computer are shown schematically; The one is a hard disk, which we will be calling a "permanent storage" in the following sections, where files and software are stored; the other one is a memory area, which we will be calling a "temporary storage", used as working space, where files and software retrieved from the permanent storage are transferred to. The OS used was Windows and the word processing software Microsoft Word was simulated. Visualization of two word processing operations involving,
(1) change in the OS control
(2) file (data) transfer
were devised, and two types of simulators were developed.

The one, which we call type A in the following sections, visualizes the computer's internal permanent and temporary storages along with the previously mentioned computer equipment, and simulates the movement of the Windows OS controls and the file transfer. The other one, which we call type B, simulates only the Windows OS controls and file transfer operations; in other words, the internal parts of the computer is not included in type B.

Furthermore, the learner's use of the simulator can be recorded to show a learning history. Visual Basic Ver. 5 was used as the language for developing the simulators.

2.2 Simulator Functions

2.2.1 Type A Simulator Functions

When the simulator starts, the same environment is presented as when the learner uses MS Word. The input-output devices as well as the computer's internal permanent and temporary storage locations that cannot be seen from the outside are displayed (see Figure 1). Although the data in the permanent storage are maintained even if the power supply is turned off, the data in the temporary storage are lost.

The simulator has a color display in order to make it easier to understand visually. Initially, the entire background is in gray and only the computer display, like the real one, is in black. The color red is used for important items. When the power is turned on, the computer display turns into a light cyan color and becomes ready for operation. At each stage, significant colors are assigned to regions where files and software such as Windows and Word are allocated. The colors are assigned based on the operations and the timing when such operations occur. When the permanent and temporary storage areas become ready for use, the background changes to light blue, and when the software or files are executed, that region's color changes to yellow, and then changes to orange the next time something is added to it. When quitting, although the area returns to the gray color, if there is text in the memory, the text is shown in black to indicate that it remains as part of the memory.

In addition, an arrow (=>) is employed to show the controls relating to Windows and Word, and another arrow (->) is used to show the file and data transfer.

In the simulator, the internal operations of the computer are reproduced according to the state transitions, and expressed according to the commands contained in Word's File menu. The names of the software, devices and areas are those of the simulator used in the simulator's screen display.

(1) Before turning on the power, the student enters his/her student identification number and name in the spaces on the screen in response to prompts for the purpose of recording the learning history.
(2) Power is turned on.
A red power switch (alternates between "on" and "off") located at the bottom right-hand corner of the display is pushed. Windows starts up from files stored in the permanent storage and the Word icon is displayed at the bottom of the display.
(3) Starting Word
Word is started using the Word icon. The permanent storage, temporary storage, and the display regions for Word are set up. [File (E)] for the file menu appears in the upper left corner of the screen. An arrow is displayed to indicate that the file transfer and the text editing operations are under Word's control.
(4) The work is proceeded by selecting the following prescribed menus from the "File" menu.

- New Document (N)
  Text is input and shown in two yellow areas indicating the temporary storage and the display. An example is shown in Figure 1.
- Open (O)
  The name of the saved document is input into the dialog box that appears on the screen. The saved file is displayed in the temporary storage and the display.
- Close (C)
  The display and the temporary storage are closed. The text of the document located in the permanent storage is displayed.
- Save (S)
  The text is added to the document in real time. It is saved in the permanent storage in the same location as the original document.
- Save As (A)
  When an arbitrary file name is input into the dialog box presented on the screen, the document in the temporary storage is transferred to the permanent storage. An example is shown in Figure 2.
- Print (P)
  The document in the temporary storage is shown for printing.
- Quit (X)
  Word is shut down and the text in the temporary storage and the display disappears. The contents of the permanent storage remain, and the region turns into gray.

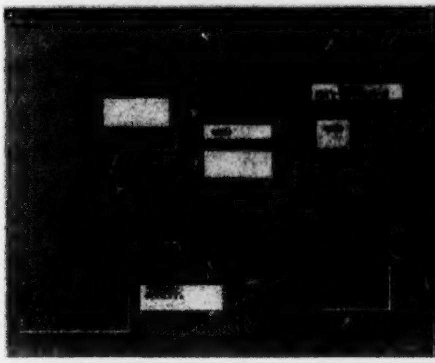


Figure 1 Example of the "New Document" menu by simulator A

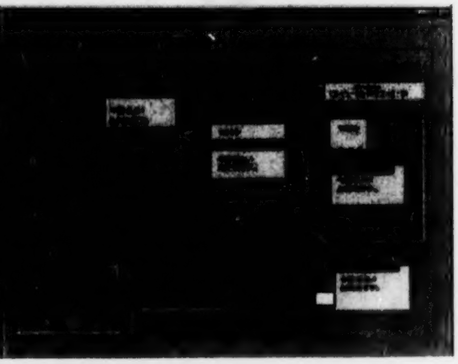


Figure 2 Example of the "Save As" menu by simulator A

BEST COPY AVAILABLE

(5) Quitting Word
To quit Word, the Quit (X) command from the File menu is selected. The learning history during the use of the simulator is saved.
(6) Power is Turned Off
The power is turned off when the power switch is pressed.

2.2.2 Type B Simulator Functions

The display of simulator B does not show the internal parts of the computer including the permanent and temporary storages unlike the previous simulator. Consequently, only the display, keyboard, printer, and the floppy disk that are seen during a normal operation of the computer are displayed. All the simulator functions related to these devices are exactly the same as the simulator A. An example of the "Print" menu is shown in Figure 3.

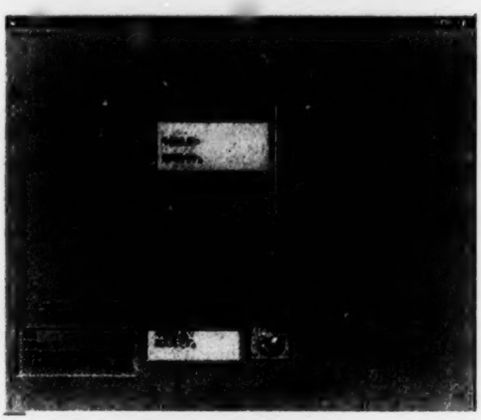


Figure 3 Example of the "print" menu by simulator B

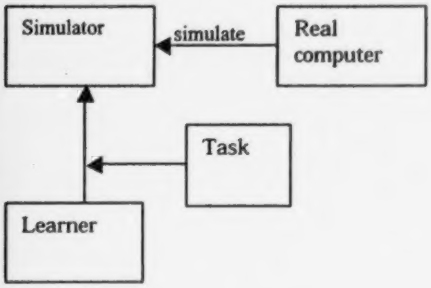


Figure 4 Usage of simulator

3 Experiment Using the Simulator

3.1 Method of the Experiment

Experiments were conducted using the two simulators, A and B. Subjects included 77 students (ranging from freshmen to seniors) from the law department of a private university. The subjects had already learned a word processing application (Word) and how to access the Internet in the first half of the semester in a beginner's computer course. Subjects were divided into two groups, with 39 subjects using the simulator A and 38 subjects using the simulator B. Both groups answered questionnaires prior to their participation, performed a variety of tasks using the simulators, and answered questionnaires at the end of the study. Contents of the questionnaires were the same for both simulator A and simulator B groups. The initial questionnaire asked about the subject's personal characteristics and 16 questions on the use of Word. The post-study questionnaire included the same 16 questions and additional ones related to their final impressions of using the simulator. The subjects were asked to select one of four answers (correct, probably correct, probably incorrect, and incorrect) in order to assess the subject's degree of confidence when answering.

3.2 Description of the Experiment

The following three tasks were given to both simulator A and simulator B groups during usage:
(1) Turn on the power, start Word, input text into a new document, and save the document as a named file.
(2) Open the saved file and print it.
(3) Add text to the saved file and save. Turn off the power.

These tasks were conducted in sequence and performed once without exception. The second time subjects used the simulator, they were permitted to perform any of the available functions they found interesting

BEST COPY AVAILABLE

without limitation. The usage of simulator is shown in Figure 4.

4 Results of the Experiment

4.1 Analysis of Variance of Results

Scores are analyzed by analysis of variance. The sources of variance included (1) method: the two methods employed in simulator A and simulator B respectively, (2) time: pre- and post-simulator usage, and (3) questions: the 16 questions in the questionnaire.

The answers to the questions were weighted according to the following scheme: Correct (4 points), probably correct (3 points), probably incorrect (2 points), and incorrect (1 point). The analysis of variance is shown in Table 1.

A significant difference of 1% level of significance($p<0.01$) was observed between the methods used for simulator A and Simulator B. A significant difference of 1% level of significance($p<0.01$) was also observed for time and for questions respectively. There was also interaction of 1% level of significance($p<0.01$) between time and the questions. However, there was no significant interaction between the remaining combinations, that is, between method and time, method and questions, or method, time and questions.

Table 1 Analysis of variance in simulator usage experiment

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F	
Method (type A ,type B)	1	5.769	5.769	10.30	0.0013	**
Time (pre,post)	1	14.344	14.344	25.62	0.0001	**
Question	15	312.882	20.859	37.26	0.0001	**
Time*Question	15	23.786	1.586	2.83	0.0002	**
Method*Time	1	0.355	0.355	0.63	0.4262	
Method*Question	15	5.274	0.352	0.63	0.8541	
Mthd*Time*Qstn	15	6.294	0.420	0.75	0.7350	
Error	2400	1343.71	0.560			

**$p<0.01$

An analysis of variance of pre- and post- usage of simulator A and simulator B was conducted using the mean of each subject's total scores. The results are shown in Table 2.

A significant difference of 5% ($p<0.05$) was observed with regards to pre- and post- usage of simulator A suggesting that the simulator experience had a significant effect. The pre- and post- usage of simulator B also showed a difference of less than 10% significant tendency ($p<0.10$).

In contrast, no significant difference was observed between pre-usage of simulators A and B, nor between post-usage of simulators A and B.

Table 2 Analysis of variance of pre- and post- usage of simulator

	pre	post
type A	54.744	57.564
type B	53.579	55.632

(Mean of Tatal score)

type A : Test of the difference between pre- and post- usage

	DF	Sum of Squares	Mean Square	F Value	Pr > F
Time	1	155.13	155.13	5.25	0.0247 *
Error	76	2245.03	29.54		
Total	77	2400.15			

* $p<0.05$

type B : Test of the difference between pre- and post- usage

	DF	Sum of Squares	Mean Square	F Value	Pr > F
Time	1	80.05	80.05	3.32	0.0726
Error	74	1786.11	24.14		
Total	75	1866.16			

4.2 Discussion of Analysis of Variance of the Experiment

As mentioned in 4.1, a significant difference of 1% ($p<0.01$) was seen between simulators A and B. In addition, a significant difference of 5% ($p<0.05$) was seen between the pre- and post-usage of simulator A. Thus, it is regarded that the learners' understanding increased as a result of visually experiencing the computer's internal processes and the movement of files with simulator A. Understanding how files actually move inside a computer in relation to the operations they have already learned may have contributed to clearing learners' ambiguous understanding about how computers handle files. We can therefore conclude that visualizing the internal operations of the computer by simulator A was effective.

On the other hand, there was also a significant tendency in the results of the use of simulator B. The fact that exercising conventional operations in a similar operational environment still had an effective tendency suggests that the use of the simulator helped them acquire a condensed or simplified perception of how the files are manipulated. This could also be understood from the impression gained after analyzing the post-simulator usage questionnaires.

5 Changes in student's understanding for each problem

(1) "Windows" goes into operation at start-up.
(2) "Word" is under "Windows" management.
(3) Text that is not saved will disappear when the computer is shut down.
(4) Saved files can be retrieved again.
(5) "Word" goes into operation by double-clicking an icon.
(6) The document stored inside the computer disappears when it is printed.
(7) In order to protect against lightening, long text should sometimes be saved while inputting.
(8) When a file is closed, the text displayed on the screen or in temporary storage does not disappear.
(9) When a file is opened, it is shown on the display or called to the temporary storage.
(10) When a file is closed, the saved document disappear.
(11) When a file is saved, it is contained in the storage(floppy disk or hard disk).
(12) If a blank screen is saved, the file is empty.
(13) When you quit "Word", the text is displaying on the screen.
(14) When you open a file and change the content, then it is impossible to save again.
(15) You should specify a name when retrieving a file.
(16)• It is not guaranteed that the document is saved when the system or software quits suddenly.•

Table 3 Summary of Questionnaire

The problems were 16 questions relating to the use of "Word". A simple summary is shown in Table 3.

An analysis of variance was conducted with respect to the pre- and post- usage of simulator A. The results are shown in Table 4.

The results of the F-test indicated changes before and after the simulator usage in the following situations.
(1). For simulator A, answers to Q2 (Word is controlled by Windows) showed a significant difference of 1% ($p<0.01$), Q13 (Quitting Word) also showed a significant difference of 5% ($p<0.05$), and Q5 (Word icon) showed less than 10% significant tendency of less than 10%. The post-usage effect of simulator A on questions related to the OS was quite apparent. Use of simulator A is thus thought to be successful since the students were able to grasp the general notion that the application being used was operating under the control of the OS. In particular, correct answers to Q2 increased as much as 60% with respect to the before and after ratio using simulator A, and this increase is far greater than that for simulator B (34%). This result shows that displaying the internal operations of the computer system was highly effective.

(2) Q9 (Opening a saved file) and Q11 (Saving a file) involve retrieving data from and storing data in the permanent storage which are basic file manipulation operations. In simulator A, the permanent storage and transfer operations are visualized, and showed a significant effect with a significant difference of 1% ($p<0.01$) seen for both Q9 and Q11.

Table 4 Analysis of variance of each question
pre- and post- usage of simulator A

Question	pre-typeA Mean	post-typeA Mean	F Value	Pr > F	
1	3.92	3.92	0.00	1.0000	
2	2.95	3.79	37.55	0.0001	**
3	3.56	3.56	0.00	1.0000	
4	3.90	3.95	0.71	0.4020	
5	3.21	3.56	2.90	0.0929	†
6	3.74	3.77	0.07	0.7952	
7	3.28	3.51	1.99	0.1623	
8	2.56	2.46	0.17	0.6838	
9	3.23	3.69	7.30	0.0085	**
10	3.54	3.62	0.21	0.6448	
11	3.51	3.87	7.32	0.0084	**
12	3.00	3.05	0.04	0.8408	
13	3.26	3.62	4.28	0.0421	*
14	3.79	3.74	0.20	0.6585	
15	3.82	3.90	0.77	0.3818	
16	3.46	3.54	0.28	0.5986	

number of samples : 39

** • $p<0.01$

* • $p<0.05$

† : $p<0.10$ significant tendency

6 Conclusions

Two types of simulators that simulate the operation of Word under the Windows OS were developed for the computer literacy education. Operation tests involving 77 university students were performed using both types of simulators. The results indicated that simulator A, which simulated the internal operations of the computer, was more effective.

We believe that when learning how to operate a computer, learning only the operating procedures makes it difficult to understand the status of the computer at any given moment.

Therefore, in order to help students understand what is going on in the present situation of learning, we developed a simulator that visualized internal executions. The results of the experiment using simulator A, which showed the internal executions, and simulator B, which did not, revealed the following.

(1) A significant difference of 1% ($p<0.01$) was observed between simulator A, which displayed the computer's internal executions, and simulator B, which did not. A significant difference of 5% ($p<0.05$) was seen between the pre- and post- usage of simulator A. It indicates that simulator A was more effective.

(2) Using simulator A, internal operations such as OS control, retrieving data from the permanent storage area, and saving data to the permanent storage area were well understood.

These results indicate that visualization of the internal executions of a computer is effective in computer literacy education.

Acknowledgements

The authors would like to thank Ms.Sari Shimizu for her considerable assistance, Mr.Takayuki Nakajima for his technical advice, and also Ms.Valerie Hansford and Ms.Narumi Shimizu for their useful advice and encouragement.

References

[1] Curriculum committee on the B.A. degree for computer science,"1992 Report on the curricula of computer science for general education (A research project of the Ministry of Education, Science, Sports and Culture)", Transactions of the Information Processing Society of Japan,p.182, (1993).

[2] Etsuko HARADA," Informatics and Computer Science Education for Non-Computer Science Undergraduate Students :Objective and Issues", IPSJ Magazine, Vol.41,No.3,pp.227-233.

[3] Koichi ODA(2000)," Computer Literacy Education in a Communication Department", IPSJ Magazine, Vol.41,No.3,pp. 234-238, (2000).

[4] Takako SHIMIZU, Oichi ATODA, Nobumasa TAKAHASHI,"The Use of EDSAC for an Introductory University Course on Computers and Programming", Transactions of Information Processing Society of Japan, Vol.24,No.3• pp.281-292, (1983).

[5] Takako SHIMIZU, Masahiro ISE, Mario NAKAMORI," An Environment of Laboratory Exercises of Elementary Computer Programming for the B.A.Degree in Computer Science", Transactions of the Institute of Electronics, Information and Communication Engineers A, Vol.J71-A,No.9,pp.1734 •• 1741, (1988).

[6] Stasko,J.T.,"Using Student-Built Algorithm Animations as Learning Aids", ACM SIGCSE,Vol.29,No.1, pp.25-29, (1997).

[7] Brown,M.H.," Zeus:A system for algorithm animation and multi-view editing", In Proceedings of the 1991 IEEE Workshop on Visual Languages,pp.4-9, (1991).

[8] Gloor,P.A.," AACE - algorithm animation for computer science education" , Proceedings of the 1992 IEEE Workshop on Visual Languages,pp.25-31, (1992).

[9] Roman,G.C., et al.," Pavane: A system for declarative visualization of concurrent computations", J.Visual Languages and Computing,Vol.3,No.2,pp.161-193, (1992).

[10] Katsuyuki INOUE, Katsuyasu FURUKAWA, Takeya IGARASHI, Hirotaka UOI, Masaru SUDO, "A Framework and a System for New Style Algorithm Animations", Transactions of Japanese Society for Information and Systems in Education, Vol.15,No.2,pp.55-64, (1998).

[11] Masaaki NISHI,"Learning of Computer System using a Simple Model Computer", IEICE Technical Report,Vol.99,No.332, ET99-43,pp.31-36, (1999).

[12] Ken ISHIKAWA,Mitsuo YAMAGUCHI,"Development of a Computer Simulator Based on Micro-Operations",The Transactions of the Institute of Electronics,Information and Communication Engineers A, Vol.J75-A,No.2,pp.422-430, (1992).

[13] Yoshiyasu ITOH,Eiichi HAYAKAWA,Mitarou NAMIKI,Nobumasa TAKAHASHI," A design and Implementation of OS Visualizer for Learning Support", Information Processing Society of Japan SIGOS, Vol.97,No.20,PP.171-176, (1997).

[14] Yusuke NOGUTI,Masataka Goto,Hideo TANIGUTI,Kazuo USHIJIMA," Facility for Visualizing Operating System", Information Processing Society of Japan SIGOS,Vol.96,No.38, pp.55-59, (1996).

The Criteria and Evaluation of Metadata/Keywords in Image Retrieval

Toru FUKUMOTO* and Kanji AKAHORI*
**Department of Human System Science*
Graduate School of Decision Science and Technology
Tokyo Institute of Technology
2-12-1 Ookayama, Meguro-ku, Tokyo, JAPAN
Tel/Fax: +81-3-5734-3233
E-mail: fukumoto@mail.club.ne.jp

Nowadays, a large amount of digital images are being stored worldwide in Internet. As an educational means, images stored in Internet have a big potential. Teachers can show the students pictures or images instead of actual things. The Internet is so rapidly expanding and becomes so complicated that the ways to retrieve images effectively from Internet database are now getting more difficult. In this paper we consider an image database about metadata type. We place a special emphasis on keyword itself in the metadata, and show the criteria of keyword, not the framework of them. Good keywords are needed in the database so that the retriever can get what he/she really wants. First we survey the necessity of metadata: especially keyword for image database. Next we consider and present the criteria for consistent and appropriate keywords, distinguishing subjective keywords from objective ones. And we examine and assess them. Furthermore we append a new item, importance, to our criteria.

Keywords• **Image Retrieval, Metadata, Criteria**

1 Introduction

Over the years large amounts of computer-aided images are being stored in Internet owing to widely available digital recording devices, such as digital cameras, scanners, and economical large size storage. For the effective management of those digital images, an image album or an image filing system has the subject of study and it has remarkably developed. And the Internet is so rapidly expanding and becomes so complicated that the effective retrieval methods of images from database becomes more and more important.

As an educational means, image presentation is very important. Because teachers cannot usually bring actual thing into classrooms, they show students the pictures or images instead. Or when the students use the Internet by themselves the images surely help them to learn fast and effectively.

There are 3 kinds of image database: feature type, sensitiveness type, and metadata type. Feature type (cited as [1] and [2]) is based on the colors or shapes of object in the images. When the retriever puts in color or shape, the system starts searching directly the database with color histograms or shape. In the case of sensitiveness type (cited as [3] and [4]), the retriever puts in sensitive words and the system exchanges them for color information and searches the database. In the case of metadata type (cited as [5]), each image in the database is already given metadata, which explains its characteristics by texts or digits, and the retriever searches the database using the metadata.

Our concern in this paper is of metadata type. Of this type, first, database creators define the structure or the framework of metadata. Second, database administrators attach metadata to images according to it in the database. Third, a retriever specifies texts as a key to the database. Finally the database system searches images using the metadata which is given by administrator and also using the texts which are keyed in by the retriever. Examples of metadata are keywords, texts, classification items and so on.

The metadata of image database system metadata needs consistency and appropriateness. If it often happens that some of metadata are irregular or incomplete, the retriever cannot find images which he/she really wants. Especially of commercial systems, the reputation of the database is determined by the quality of metadata.

We place special emphasis on keywords in the metadata because they are the basic component of metadata. In Section 2 the necessity of metadata, especially keyword of image database, is discussed. In Section 3 the criteria of consistent and appropriate keywords is considered. In Section 4 the criterion, which we discussed in Section 3, is examined. In Section 5 our conclusion is presented and the future work is discussed.

By the way, we are not concerned here the structure or the framework of metadata. It needs another consideration. In ISO, the structure of metadata for multimedia contents description, MPEG-7 [6], is now being standardized. MPEG-7 will provide the distribution and utilization of multimedia contents with content-based retrieval. The application will be distance learning, a stream database, a personal TV, and so on. MPEG-7 will become International Standard at September 2001.

2 Metadata and Keyword

Good metadata is needed in the database so that the retriever can get what he/she really wants. In storing database with images, we give texts, especially words as metadata to them. These words can be defined as keywords. They are given to images and used when a retriever searches the database. Database system searches images based on keywords which he/she specifies.

Therefore when incompatible keywords are given to images in the database, a retriever cannot get images which he/she really wants, even if he/she puts in any compatible keywords. In next Section we show the criteria of good keyword, which discussed and experienced before in [7].

3 The criteria of keyword

We shall discuss the criteria of keyword in detail.

- Giving appropriate keywords

A retriever depends only on keywords. Therefore the images need to be given beforehand the keywords which represent them precisely. For example, we should distinguish "people" from "doll" because he/she may really want the image of a doll, not of people. Or it depends on the retrievers of the database which is appropriate "car" or "BMW". The database administrator should expect how the retriever uses keywords when he/she gives keywords to the image.

- As many keywords as possible

An image has a lot of views. For an example, in Figure• ; some people takes it for the figure of pond, some of others for monument. Obviously only a single keyword is not adequate to describe its whole concept.

Therefore, a number of keywords should be given to an image so that it can precisely correspond to the keywords. The retriever can more easily obtain the images which he/she really wants.

- Distinguish subjective keywords from objective

We can define a lot of keywords for one image. They may be divided into two types. One is objective; the other is subjective. In figure• ; objective keywords are, for example, "pond", and "monument". Whereas "summer" and "shine" are subjective factors, because they are viewer's impressions of this image. They are subjective keywords. The former is more general than the latter.

You might think that you need only objective keywords. However, a retriever's needs are generally divided into two types: subjective and objective. In Figure• ; he/she wants a summer picture. "Summer" is a subjective word. If the database does not have subjective keyword, he/she cannot find such an image. He/she must hit objective keywords instead of "summer". Accordingly there are subjective needs in so many cases that subjective keywords are to be needed. For this reason, both subjective and objective keywords are needed in an image database.

And subjective keywords are to be distinguished from objective ones. Here is an example. A retriever wants an image of "sea atmosphere". In a database, one image represents the impression of sea, that is, "beach". The other image represents the sea itself. When he/she specifies a keyword "sea", the database system searches an image with keyword "sea". It hits two images: the sea itself and the beach. However, what he/she really wants is the sea image, not a beach one. So that a subjective keyword should be given a subjective marker in the database, to distinguish it from objective one. The retriever finds the image more easily and precisely by putting in the keywords with a subjective marker. Such is the criteria of keyword.

4 Examination and Assessment of the criteria

We examined above mentioned criteria to assess the effectiveness.

We arranged seven persons (5 males and 2 females; all adults). First of all, we showed them our criteria discussed in Section 3 as a book-style. We call it "keyword book". Next, we show them 20 images, one per one paper. The contents of them are sight, animals, texture and so on. We included pictures of various image types. We scanned, digitized and printed pictures by a color laser printer. Then we let them give keywords to these images. They gave keywords to the images referring the keyword book as many as they liked. We did not limit the number of keywords for each image.

Finally we let 3 specialists give keywords to same images separately. And we compared the former keywords (by 7 persons) with the latter keywords (by 3 specialists) so that we might assess the contents of both keywords. In the following section we discuss about the result of this examination.

4.1 Number of keywords and the appropriateness

The result of our experiment are presented in Table• ; Total number of keywords is 416 for 20 images. In average there are about 21 keywords for an image. The relationship of keywords and object in each image is roughly as many. The specialists added total 103 keywords to those given 7 persons.

It is the tendency that specialists give keywords to the small objects in each image. Especially there are a lot of objective keywords, which are given to images that has many objects. 7 persons and 3 specialists gave the same keywords to Figure• ; But to Figure • •7 persons gave only 5 keywords: while 3 specialists did 29. And the keywords by 7 persons are different from the ones by 3 specialists.

The keyword is for retrieval. We need not say that keywords should be given to as many as possible to improve the preciseness simply because the objects in the image are very small. Generally the more keywords the image is given, the easilier it can be searched out. But, on the contrary, from the point of appropriateness, we claim that the images should be added the information regarding the objects in it; for example, how large it is, or what impression a person has when he/she looks at it. This is to help the retriever to obtain the image which he/she really wants. The database should have such information. However, there is no information about them in our criteria.

It follows that an index is needed to show the importance of keywords or square measure of objects in the image: for example, the keyword "monument" and importance "3", or monument has one-fifth (of the image).

To the images that cannot be distinguished by the object such as texture and patterns, the keywords of 7 persons vary widely compared with ones by specialists. For example, in Figure • • 7 persons gave "red", "water-drop" and "discomfort". The object in it is so hard to define that they are difficult to give keywords to this texture and pattern. In educational situation, this is a serious matter because students are not generally able to hit such keywords to retrieve them. In short, we point out that metadata type is of limited use when images are given in pattern or texture style. So that it seems reasonable to say that feature type retrieve is better for them than metadata type.

4.2 subjective/objective keywords

In Table• ; subjective keywords are 81, 21 % of total keywords. And the specialists gave 7 subjective keywords, which is 10 % of 7 persons' keywords. On the other hand, the specialists gave 96 objective keywords.

Regarding subjective keywords, there is little difference between 3 specialists' and 7 persons'. On the contrary, regarding objective keywords, 3 specialists' are different from 7 persons'. In addition to this, 7 persons' keywords are lacking of uniformity. There are only a small number of common subjective keyword that both 3 specialists and 7 persons.

Therefore it follows that there are limited words that express the character of images subjectively. The number of subjective keywords using these limited words is so small. On the other hand, regarding the objective keywords, 7 persons mostly attached them to even the objects which occupy the main part of the image, while 3 specialists gave them to even the small objects. We may say that that caused the increase of their keywords.

	Total	Subjective	Objective
Seven Persons	313	74	239
Three Specialists	103	7	96
Total	416	81	335

Table• •Number of Keywords

4.3 Discussion about our criteria

As mentioned above, we must modify our criteria because they will be to include the importance of each keyword.

- Appropriateness• The database administrator should expect how the retriever uses keywords when he/she attaches keywords to the image. As mentioned above, he/she distinguishes or identify "car" with "BMW". If the database is for general use, both general noun "car" and proper noun "BMW" are also given.

- Number of keywords• It needs the number of object that the image has and at least one subjective keyword which express the characteristics of image.

- Importance• It newly is appended our criteria. Importance: 3 is that the object is very large in the image or that it express the characteristics or the main theme of the image. Importance 1 is that the object is as small in the image as people try to find. The other object or character in the image is importance 2. For example, in Figure • ; keyword: keyboard, importance: 1; keyword: PC importance: 2 and in Figure• ;keyword: cat, importance:3.

- Subjectiveness/objectiveness• objective keywords should be given for all object in the image and subjective ones are given to at least one word for the impression by the image. Each keyword is appended subjective/objective marker or one s coded to numerically.

5 Conclusion

In this paper, we considered and the criteria of metadata, especially keywords for image database and image retrieval. We emphasized importance of consistency and appropriateness. We examined the criteria by experimenting 10 testers and verified them. And we added a new measures, "Importance" to our criteria

When a lot of persons give keywords to images, such criteria are indispensable. In our future study, we will concerned and define the structure or the framework of metadata. Furthermore, We will integrate metadata type and feature type for pattern or texture.

In the future, we hope that multimedia retrieval with metadata will be much easier for all people. So the teachers will be able to utilize more accurate images in education, and the students will be able to easily retrieve images from Internet.

References

[1] Kazuhiko KUSHIMA et.al., "Content based Image Retrieval Techniques based on Image Features", Trans. IPS. Japan Vol.40 No.SIG3 (TOD1), pp.171-184 (1999).

[2] M.Flickner et.al., "Query by Image and Video Content: The QBIC System", IEEE Computer, Vol28 No.9pp.23-32 (1995).

[3] Haruo KIMOTO, "An Image Retrieval System Using Impressional Words and the Evaluation of the System", Trans. IPS. Japan Vol.40 No3, pp.886-898 (1999).

[4] Shoji TANAKA et.al., "A Study Concerning Automatic Addition of Impression Keywords to Natural Images", Tech. Report of IEICE HIP96-20, pp.19-24 (1996).

[5] Yasushi KIYOKI et.al., "A Semantic Search Method and Its Learning Mechanism for Image Databases Based on a Mathematical Model of Meaning", Trans. IEICE Japan D-• Vol.J79-D-• No.4, pp.509-519 (1996).

[6] MPEG Web Page: http://drogo.cselt/it/mpeg (accessed on July 1, 2000).

[7] Toru FUKUMOTO, "The Keyword Attachment Reference for the Integration of Image Retrieval", Conference Proceedings of the 1999 Conference of Japan Society for Educational Technology, pp.169-170 (1999).

[8] Hiroaki OOBA et.al., "Image Retrieval by Natural Language", JSAI SIG-HICGT-9202-4, pp.25-34 (1992).

Figure• • an example of image

Figure • • image with one object

Figure• • image with many objects

Figure• • Texture

BEST COPY AVAILABLE

The Research on Difficulty of Asynchronous Learning Materials Based on Studying Time Distribution

Wu-Yuin Hwang and Rueng-Lueng Shiu
Information and Computer Education
National Kouhsiung Normal Univeristy
wyhwang@nknucc.nknu.edu.tw

The purpose of asynchronous distance learning systems is to enhance students' learning performance in the internet. In this paper, we investigate the characteristics of the asynchronous materials and propose the criteria to evaluate them. Employing the criteria, the materials could be adjusted to meet most students' learning pace. First, the TDC (time-distributed curve) which is a learning curve is derived from students' studying time distribution. By the TDC, it is obtained that the more difficult the materials of the chapter are the steeper the TDC becomes. Also the total learning time of each chapter indicates the quantity of the matter. Employing the total time of each chapter, we could evaluate whether the quantity of the matter is sufficient to match students' learning desire.

Keywords: **distance learning, learning portfolio, learning behavior, learing time distribution**

1 Introcduction

1.1 The distribution of learning time with learning attitude

Teachers could interact with their students immediately at the classroom. Thus, they could get the learning behavior of their students by students' response. The learning behavior is regarded as a good measure to evaluate learning performance. But it is really hard to obtain every student's learning process and attitude because there are at least 30 students in each class. However, employing the database technology in asynchronous learning systems, it is possible to obtain all of the student's learning process and studying time.

1.2 Learning time distribution

In traditional education, students learning together in the classroom at the fixed time, and teachers control the course proceeding. But it is difficult to pay attention to all students. However, asynchronous learning systems not only provide a brand-new perspective to long-life learning but also keep track of learning time of all students. In accordance with the learning time of all students, teachers could modify the matter to match learning goals.

2 Experiment and analysis

The experimental course in our asynchronous learning system is "Basic computer concept", the materials of the course are divided into 12 chapters. The progress-control mechanism is that students need to finish the homework of the chapter in order to be promoted to the next chapter. Thirty participants engage in this experiment and they are all teachers.

The student' s learning time and login time are recorded by technologies of ASP(Active Server Page) and Database. Therefore, we could get which chapter students read and how long they read the chapter. The important curve, Time-Distributed Curve (TDC), is generated by linear regression analysis. From the slope and the area of TDC, some characteristics and results are obtained.

2.1 TDC and DCA (Degree of Course Acceptance)

Student' s reading time each chapter is recorded in our experiment. The recorded time begins from the date when the teaching materials are put in the internet for 15 days. In each chapter, all of the student' s learning time everyday is summed up.

Employing the recorded data and derived chart, each chapter has a unique TDC (time-distributed curve) by linear regression analysis. According to the time-distributed curve, teachers may decide whether the materials should be improved.

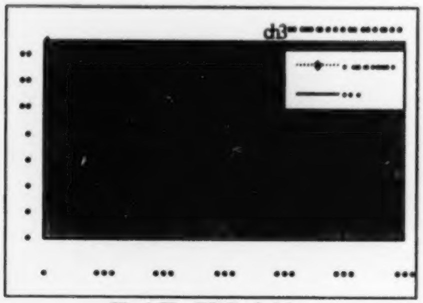


Fig.1 The TDC of ch3

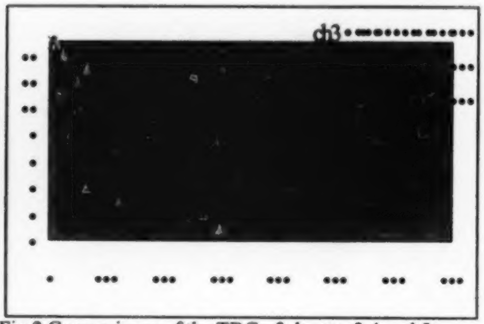


Fig.2 Comparisons of the TDC of chapter 3,4 and 5.

In Fig. 1, the X axle indicates time value and its time unit is one minute not an hour and The Y axle indicates days. For example, the total time on the 4th day is approximate 150 minutes. The slope of the TDC is minus because the total studying time would decrease while students proceed to study the matter.

The value of the slope is required to be concerned. The larger the value of the slope is, the smoother the TDC becomes. For example, figure 2 made comparisons of the TDC of chapter 3,4 and 5. Obviously, the TDC of chapter 4 has the smallest slope because it is the steepest one. And the TDC slope of chapter 3 is slightly larger than that of chapter 5. Thus, it is the most difficult to read chapter 4 and it is the easiest to read chapter 3. The reasons why the materials are hard to study may be either the materials are complicated or the user interface is not friendly to read. According to the above description, the slope of TDC could be termed as Degree of Course Acceptance (DCA, It means the harder the topic to read the smaller is the DCA.)• Besides the TDC' s slope is proposed to determine the degree of materials acceptance, there is another important characteristic, the area of the TDC, to influence the amount of learning time.

Based on the area and slope of TDC, the difficulty and quantity of the materials could be evaluated. According to the above description, it is shown that the quantity of materials would affect the amount of learner' s studying time, also the difficulty of materials would affect the length of learning period. Due to these reasons, there are two margin lines, quantity and difficulty, in Fig. 3. The two margin lines are termed e are "Margin Line Of Quantity (MLOQ)" and "Margin Line Of Difficulty (MLOD)". There are plentiful materials on the right of MLOQ, but there are poor on the left side. The upper of MLOD the materials are located the harder they are read, but lower are easy.

Since the features of MLOQ,MLOD,DCA and the area of TDC are proposed, there are four kinds of situations that the TDC represents as follow:

1. It is easy to read the material, and the contents are plentiful.
2. It is easy to read the material, but the contents are poor.
3. It is hard to read the material, but the contents are poor.
4. It is hard to read the material, and the contents are plentiful.

BEST COPY AVAILABLE

The MLOQ and MLOD could be employed to enhance discriminating the difficulty of the materials if the DCA and the TDC's area of the chapters are different. Finally, how is the value of the MLOQ and MLOD obtained? The MLOQ is the average of all students' learning time of one chapter. The MLOD is the average of all students' learning days of one chapter.

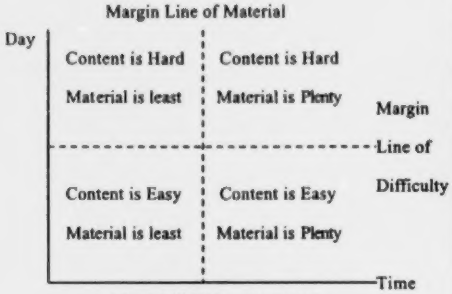


Fig.3 MLOQ and MLOD

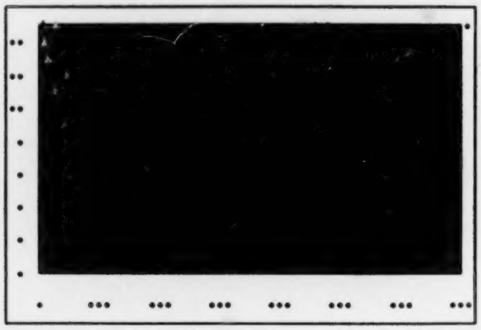


Fig.4 Compares the TDCs of the ch5 & 7

2.2 Time distribution of the interdependent course

What else may affect one' s effort in the course? There are relationships between two topics. For example, there are relationships of dependency between chapter 5(Internet I) and 7(Internet II). Generally, the topic "Internet I" is dedicated to construct the fundamental concept and "Internet II" introduces the advanced ideas and practice. According to the normal teaching policy in both topics, the "Internet I" should have fewer and simpler materials than the "Internet II". Thus learners spent much less time to study "Internet I" than "Internet II".

Fig.4 compares the TDCs of the two chapters. As shown in Fig. 4, it is easy to find out chapter 7 has a smaller DCA (the slope of TDC), that is, chapter 7 is harder than chapter 5. Furthermore, the area of chapter 7 is less than that of chapter 5. The TDC of chapter 5 is located at approximately 11 on Y axle and 600 on X axle and the TDC of chapter 7 located at 12 on Y axle and 280 on X axle. According to MLOQ and MLOD as shown in fig.3, we concluded that "The chapter 7 is more difficult than chapter 5, but its quantities are much less". It is different from we described before, "Internet I" should have fewer matters than "Internet II". In our experiment, we provided much more contents in chapter 5 than chapter 7. Therefore the amount of materials in chapter 5 should be reduced.

3 Conclusions

The asynchronous learning service is an on-line collection of hypertext that provides us a new way to learn. Their students with different native intelligence come from any place and go to learn when they would like. It is very important to design and evaluate the asynchronous teaching matters so as to match teaching goals. This paper proposed some basic criteria to investigate the characteristics of teaching matters, then gave an advise to modify them to meet the learning desire. The basic criteria, the area and slope of TDC, are derived from learning time distribution. Through the basic criteria, instructors could modify the materials in accordance with most students' learning pace and talent. Especially, our proposed mechanism is worth much attention to develop the adaptive learning system. Once the asynchronous learner' s studying portfolio is available, the materials could be real-time adjusted to match the learner' s state.

Reference

[1] • • • • • • • • • • • • • v• • • • • • • • • • v• • • • • • • • • ;pp 13-25, 67 • ;1998• •
[2] • • • • • • • • v• • • • • • • • • • • • • • • • • • v, •
[3] • • • • • • • • • v• • • • • • • • • WEB • • • • • • • • • • • • • • v• The 8th International Conference on Computer-Assisted Instruction• pp391-399,1998

BEST COPY AVAILABLE

The Usability Aspects of an Universal Brokerage and Delivery System for the Pan-European Higher Education

Borka Jerman-Blažic
University of Ljubljana, Faculty of Economics and Jož ef Stefan Institute
Jamova 39, Ljubljana, Slovenia
Borka@e5.ijs.si

This paper gives short overview of a recently launched EU project for universal exchange of university course units for the higher education based on a brokerage and delivery system model. The basic components and characteristics of the approache are described. More attention is given to the approach that will be used for assesment of the innovation and for evaluation of the learning and educational achievements.

Keywords: **distance learning, brokerage and delivery system**

1 Introduction

The new technologies are transforming the ways business operate and the ways people work. They are also reshaping the expectations, needs, and opportuniies in education and learning. The customers of the education market are forcing the education to become demand-led, rather than production driven. The current technologies are providing basis for a new just in time, on demand approach the electronic educational products to be offered by virtual or classical universities through special platforms acting as intermediaries between the consumers and the suppliers of educational material. It is clear that the new tecnology alone will not make this new model of more efficient education to happen by itself. Rather, new innovative models of production, brokerage, delivery and presentation are needed that will put together the participants of the education process to collaborate globally and to use the advantages of the powerful technology.

The European project »UNIVERSAL-brokerage and delivery system for exchange of university course units for the Pan European Higher education« [1] is one of the attempts this model to start to work. The project is part of the Vth Framework program of User friendly information society [2] funded by the Commission of European union. The project started in March this year and will last 3 years. The conzortium of the project is large as it encompassess 17 partners from EU[3], among them twelve higher education instituitions from all over Europe, two research organisations, one SME[4] and two telecom service providers. The consortium has also partners from outside Europe as the model developed is expected to have global applications. These are: the Moscow research institut, HEC from Montreal and Nanyang Technological University from Singapore.

The model and the implementation in UNIVERSAL is based on an education brokerage and delivery system being developed to incorporate training by provision of valued-added services to both the customers of the system and the suppliers of the educational material. The major characteristic of the system is offer of different types of learning and delivery of the educational material and its distributive nature. There is no central site for delivery of educational material. Additional characteristic of the model is the system that will be developed for pan-european acreditation of the purchased and performed university course units by the participants belonging to institutions of the European higher education system. At this early stage of the project is not possible to predict all expected circumstances and consequences that such system may have in the furure development of the educationa nad training. Brokergae approach in provision of distance education must first address a number of technological and educational issues which are part of the UNIVERSAL work program. In depth discussion of the pedagogical paradigms that may take place as well as te number of technological issues of the work program are not possible to be discussed in this article because of space restriction. Here, we concentrate on the basic characteristic of the model; highlithing the implementation scenario and giving more information about the usability aspects of the technology that will be evaluated through monitoring of the educational.

---

[1] UNIVERSAL -IST-1999-11747

[2] URL:http://www.ispo.cec.int

[3] EU stands for European Union

[4] SME- Small or Medium Size Enterprise

2 The model and the architecture of the system

The model being developed is based on creation of an open, cross-border, educational market environment coupling brokerage and delivery of "live" and "packaged"[5] courses. The proposed framework accommodates and adds value to the various business models and course structures employed in European HEI[6] institutions. It will enable:

- a single faculty wishing to experiment with the simple import of external material to enrich a specific course,
- an existing alliance between institutions to make their exchange more efficient and to enrich it with types of course units not previously exchanged,
- an Open University to extend the range and depth of its courses.

The UNIVERSAL brokerage platform is an interactive hypermedia environment offered to the academics and administrators of European educational institutions to plan and select courses. It de-couple offers and course units provision on the supply side from enquiry, booking and delivery on the demand side. The most important element that enable this de-coupling is the catalogue of offered educational material and the supporting processes, that adequately describes all the properties, educational and technological of the course units. This approach is implemented as brokerage platform and a number of delivery platforms, see Fig.1.

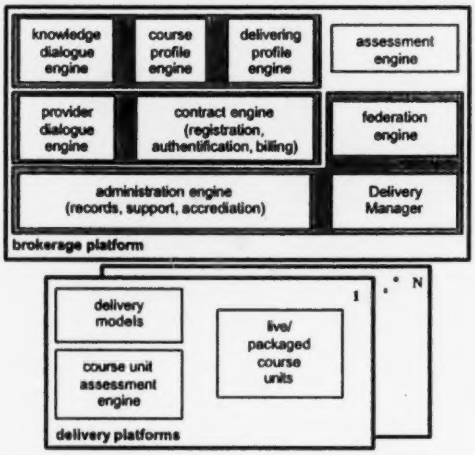

knowledge dialogue engine
course profile engine
delivering profile engine
assessment engine
provider dialogue engine
contract engine (registration, authentification, billing)
federation engine
administration engine (records, support, accrediation)
Delivery Manager
brokerage platform
1
N
delivery models
live/ packaged course units
course unit assessment engine
delivery platforms

Fig.1 The general architecture

The brokerage platform is further divided in a customer part, a provider part and an administration part. In the customer part, a knowledge dialogue engine is responsible for the dialogue to the demanding institution or to the enquiring student. When interacting with customers, the dialogue engine establishes their background knowledge and guides them in the selection of a course unit. Prospective customers are presented with choices according to a) pre-requisites and conditions attached to different types of courses (course profile engine), b) the suitability of different Institutions offering courses and c) the different delivery modes available for a particular course (delivery profile engine). Students will be able to make inquiries and express interest in course units that their home institutions have pre-selected and are willing to recognise and give credit. [7]In the provider part a provider dialogue engine is mainly used for feedback from the system back to the content provider. It is also used to handle the offer of content provision to the brokerage system to help academic and administrator users to plan new courses, submit course units, obtain customer records as well as learning progress profiles and assessment results. Demands for course units are sent to the administration engine, which looks for, offered course units fitting into the demand profile. The contract engine sets up the contract between offering and demanding side, thus it is dealing with registration, authentication and billing. In the administration part the system is driven by the administration engine, which is mainly a service database combined with a search engine. The tasks of observing and managing course scheduling and delivery issues, as well as timed interactions between the system and customers to enable the provision of joint courses are the responsibility of the delivery manager. The federation engine is dealing with distribution issues of the engineering implementation, like consistency, caching, forwarding of requests.

---

[5] Packaged courses are multi-media textbooks and WWW based courses, live courses are CWCS broadcasted courses

[6] HEI stands for Higher Education Institution

For each class of course unit there is an appropriate delivery platform. Variations in delivery platforms are due to the nature of the interactions and differences in media content and formats. The project will implement a limited range of delivery platforms, linked to the brokerage platform, sufficient to show the potential of the model. Each delivery platform contains an inherent delivery model and specific elements dealing with the media content itself.

3 The technology applied

The technology used is ubiquitous, Internet based, offering common, portable solutions and large-scale, shared, cross-border systems. These systems include, but are not restricted to:
Brokerage system is WEB based with Internet links. It is a central point of information, control and administration and logically will be centralized which means that only certain parts will be distributed or redundant for reasons of performance and high availability. The brokerage system will essentially be an E-business system that uses technologies like XML, Java / RMI, CORBA / ODP traders or agent based systems. standard security technology and intrinsic service negotiation for content delivery. Advanced transaction and billing functionality based on AAA [8] security technology, implement sophisticated administration and monitoring interfaces to the delivery systems and the integration of assessment capabilities

Delivery system similarly to the brokerage platform consists of an existing product/technology plus some enhancements ("glue" or "shell" around it), that acts as mediator between the delivery system and the brokerage platform. Defining a unique architecture for this interfacing allows adding additional systems / products by just implementing the appropriate interfaces that plug into the general architecture. A delivery system within the general architecture (see Fig.1) consists of content source, network and content sink. The content source can be a standalone system or part of a broader platform. The same applies to the content sink. The following delivery systems previously tested and used will cover the required functionality: Non-real-time delivery systems: retrieval of non-real-time mono-media and multimedia contents (e.g. browsing through text and hypertext information, download of content files). Real-time A/V systems: Real-time retrieval of multimedia contents (stored and live contents including A/V material like MPEG-2 streams) in synchronous and asynchronous manner (on-demand, live and scheduled broadcast scenarios) using IP technology (unicast, multicast), and broadband technology (ATM, ADSL,). CSCW systems: Videoconferencing and Computer supported co-operative work (CSCW) to enable interactive forms of tele-lectures combining parallel transmission of A/V streams and course material (e.g. slides) with the possibility to interact with the lecturer as well as with other parts of the audience. This family of delivery systems shall also support real-time experiments, simulations and case studies.

---

[7] Scheduling of actual course units remains the prerogative of the institutions and booking of places on courses is considered to be an internal function of the institutions

[8] AAA stands for Authentication, Authorization and Access Control

All delivery systems are inter-working with the brokerage platform and content provider systems to synchronise announcement and content delivery, to guarantee controlled user access, and to manage selection, compatibility and resource usage in delivery. All supported delivery modes will be available as profiles of the A/V delivery family. This means that each content provider can easily select the appropriate profile according to the nature of his contents and his network resources. It is important to note that used the A/V delivery technology is not based on the current average bandwidth and quality availability of the ubiquitous Internet. It will offer real high quality of A/V contents as broadband communication over the Internet (with technologies like ADSL) for a relevant number of users is available in Europe as well as the broadband services emerging in the convergence technology market (broadband over Satellite or cable-TV, interactive digital TV services) are expected to boost the widespread usage of broadband A/V information in the global IT environment. CSCW technology applied follows the principle of standards compliance and openness as for example the powerful CSCW tool ISABEL, developed in the RACE and ACTS projects ISABEL and NICE, then the standards-based (e.g. ITU H.323) COTS products (e.g. MS NetMeeting), MBONE multimedia conferencing tools (VIC, VAT, WB) developed within project MECCANO etc.

4 Content provision and description

The general architecture and model envisaged as a point of interaction of "sellers and buyers" on one hand, and of "place of commerce for actual content" requires an intelligent abstract description of the contents. Therefore, meta-data standards for multimedia contents and for educational environments are applied in the catalogue building of course units. The meta data system used is based on the specification of the IEEE LOM 3.8 meta-data scheme[9] with some extensions relevant to the platform developed as for example: attributes that specify the copyright and IPR[10] protection, attributes that describe information about digital signatures, watermarking, attributes that describe the network requirements for provision of appropriate quality of service, attributes relevant to live content and attributes defining the type of the course unit which may be: packaged, live, CSWC or mixed. The content provision and course description is based on a meta-dada system selected from available standard documents or previous projects results (1).

Several projects, that have investigated the management of information retrieval and the utilization of metadata for education and training have already proposed sets of meta-data requirements, like the Instructional Management System (IMS) project in the US (2) or the GESTALT (3) project in Europe. Some of the proposed sets have been evaluated and selected for the use in the UNIVERSAL project.

They are:

- **Learning resource content meta-data:**

Learning resource content meta data that enables cataloguing of contents of arbitrary aggregation level. UNIVERSAL supports the following granularity levels: *Fragment (Course Unit)*, *Lesson*, *Module* and *Course*. Each learning resource submitted by the "seller" is classified according to the aggregation levels and is added to the UNIVERSAL catalogue. UNIVERSAL supports "packaged" learning content, which is asynchronous in nature and synchronous learning content. Synchronous learning content is delivered as live transmissions of lectures, optionally supplemented by synchronous group ware communication technology. The special or unique features of the live content is described by specially developed attributes that are not part of the current existing meta-data standards.

- **Course structure meta-data:**

The UNIVERSAL brokerage platform not enables "buyers" to locate, use and re-use single course units. A functionality of the brokerage platform enables combination of single course units into higher levels of aggregation e.g. for full subject. This allows production of "custom" tailored complete courses. This is reflected in the course structure meta enabled by Course Structure Format (CSF) defined by the AICC and the ADL (1).

---

[9] IEEE Learning Objects Metadata document by WG 12 of IEEE Learning Technology Standardization Committee, URL:http://ltsc.ieee.org/wg12/scheme.html

[10] IPR stands for Intellectual Property Rights

- **Contents packaging meta-data:**

Like many other LMS, the UNIVERSAL platform offers the possibility to access packaged course units, which are mainly pre-recorded. Packaged courses enable an interaction with the contents itself, the interaction with the lecturer is usually not offered. UNIVERSAL packaged courses are described according to well-defined rules, specified e.g. in available standards like the IMS CPS (Content Packaging Specification).

- **Descriptive information about assessment procedures:**

Assessment is an important concept in on-line education and learning. Although the UNIVERSAL platform is not designed to assess the student' s advancement and the learning achievement, it will enable consumers or "buyers" to assess the functionality and usability of the platform and the delivery process. The assessment is performed with on line involvement of the students. Student' s responses will be captured using some form of structured mechanism with designed template(s) for such purpose. This is especially required in the cases when questions in the templates involve multiple choice, matched items, text selection, etc. Several structures exits for this purpose already: QML, SATML, and the IMS "Question and Test Interoperability Information Model" (QTI), UNIVERSAL team will decide which of the proposed template will be used for particular part of the platform and the delivery system used.

- **Meta-data for synchronisation:**

The asset management is important if the system is built up from re-usable learning resources e.g. units of lower aggregation level as is the case with UNIVERSAL catalogue. . In such cases the lifecycle management of the unit must be supported e.g. a component is not deleted from the asset management system in cases when the course unit is added to a module or larger course. This property of the system is described within the meta-data for synchronisation.

The UNIVERSAL consortium brings together a selected group of engineering and business schools across Europe who are interested in pooling their academic resources for the purpose of broadening the choice of courses and pedagogical materials offered to students and teachers and to provide opportunities for international collaborative learning. Although a few of its members have already established bi-lateral academic exchange programmes, in the initial phase of the project, partners are collecting course units developed within particular partner or outside in order to build a catalogue for the greatest market potential for the brokerage platform. The catalogue contains in addition to the meta-data information also: brief description of the educational objectives of the academic content for the students to whom courses are offered. In addition to that, brief description of teaching methodology used at each institution, description of the academic calendar for each institution, and description of the academic accreditation process for each institution are also information provided in the catalogue. Currently course units are collected from the following fields: Introduction to Information Systems, Regional Economic Development and Telecommunication, Global Marketing Management, Business Case studies, Metallurgy simulations and experiments, Foreign Languages and Cross-cultural Behaviour, Statistics for Economist, Tele-management.

The UNIVERSAL brokerage platform enables to locate, use and re-use single course units and combine single course units into higher levels of aggregation. This approach makes possible a definition of custom tailored structure for a complete course, which will lead, to a definition of a standard system of granularity for learning resources with the other projects from the IST cluster "Flexible University".

Several institutions already made suggestions for a hierarchy of aggregation levels. The IEEE LTSC and the IMS so far define four levels of granularity: *Fragment*, *Lesson*, *Module* and *Course*. Some other US based systems of aggregation can be found in the bibliography enclosed (8).

A course structure representation defines all of the course elements, the course structure, and all external references necessary to represent a course and its intended behaviour. The ADL together with the AICC, IEEE and IMS have developed the so-called Course Structure Format (CSF) which was the recommended approach for the UNIVERSAL project. The CSF promotes reuse of entire courses and encourages the reuse of course components by exposing all the details of each course element. The CSF is intended to reduce or eliminate dependency of a course on a particular LMS implementation.

The CSF is also intended to represent a wide variety of course structures and content "aggregations".

Content structures can be represented by the CSF that range from very small "chunks" of content – as simple as a few lines of Hypertext Markup Language (HTML) or short media clip – to highly interactive learning content that is tracked by an LMS. The CSF is neutral about the complexity of content, the number of hierarchical levels of a particular course (i.e., "granularity"), and the instructional methodology employed to design a course.

The UNIVERSAL platform incorporates continuous assessment of content and the system itself based on the interactions between the customers using the delivery of course units and the system itself. This information will be used to improve the overall scheme and the content to teachers, administrators and other possible customers.

5 The usability and evaluation

"Evaluation is the activity that throughout the planning and delivery of innovative programs enables those involved to learn and make judgement about the outcomes of the innovation concerned "[11]. The UNIVERSAL project aims also to develop tools to monitor the innovation process of education and learning and to develop best practice guidance.

The assessment of the content and the overall system, components for functional assessment are incorporated in both the brokerage system and in each of the delivery systems. Results from previous projects including the deployment of trans-national multimedia learning schemes[12] have shown that it is vital that all participants involved in the creation of the exchange platform and its educational content have a mutual understanding of the platform' s operations, functions and of the components' interaction. To fulfill this goal it is necessary to give the users the tools enabling an easy the use of the exchange platform such as: an administrator guide, oriented towards the management of the platform, from a technical ("how to use") point of view as well as from a content ("what to do") point of view; a user guide, describing the day-to-day use of the system e.g. to a teacher wishing to use content available through the platform (how to access the catalogue, how to book a live course, etc). In addition, in the case of "live" delivery systems (on-line live courses with CSWC), experience have shown that it is necessary to organise "hands-on" training sessions to free the teacher from the fear of new tools and to strengthen their "moderation" skills when working with a geographically distributed class through a TV-like systems. Classes in the live courses will be mainly cross-border meaning that most participants will not be working in their mother tongue and there will be a mix of cultures present in any one of the classes. As part of the preparation for participation in the main trials a short "Language & Behaviour" courses that will (I) help participants with their colloquial English (since the majority of the courses will be held in English) and (II) help them be aware of differences in cultural behaviour, e.g. questioning style will be provided.

The student/teacher ratio varies greatly among the UNIVERSAL consortium partners. A set of software monitoring tools are being studied to be implemented into the brokerage platform to make it possible for students to continuously assess their personal progress and to choose the academic path best adapted to his or her acquired knowledge and skills; for course unit providers tools will be used to improve the effectiveness of programmes offered to learners and modify content accordingly; tools will be used also to analyze the way learners use the courseware provided; to enable a global assessment of the usability of the platform etc. The monitoring tools as well as the usability evaluation techniques used for assessment of the innovation technology approach are being developed/selected in accordance with the ACTS Usability Evaluation Guidelines[13]. These guidelines define the testing and evaluation methods, experiments design, definitions of interviews, observations, heuristic evaluation and surveys.

The evaluation instruments for courseware evaluation and corresponding measures will include:

- Pre-task/post-task questionnaires
- Task experience questionnaires
- Computer experience questionnaires
- Exams or assessment of performance
- Post course questionnaires

---

[11] Stern(1988) in Evaluation of Learning Technology Implementation, by Barry Jackson, URL:http://ltdi.icbl.hw.ac.uk

[12] Project LEVERAGE AC 109 from the IV Framework Program-ACTS

[13] USINACTS – AC224, IV Framework Program -ACTS

- Knowledge quizzes
- Logs - logging times

The approach for educational assessment will follow the practical guidelines developed within the LTDI technology developed within the Learning Technology Dissemination Initiative funded by the Scottish Higher Education Funding Council[14]. As a result of this a set of guidelines identifying best practices for future users of an academic brokerage platform will be produced. Academic partners will have the possibility to review the existing experiences and pool their lessons learned from prior involvement in flexible, distance, and collaborative teaching and learning programmes. This information cover issues such as the choice and format for resources provided to students and teachers, access to tutors or teachers, methodology, independent study and collaborate work, learner motivation, learner monitoring, course accreditation etc.

6 Conclusion

The UNIVERSAL is a project that implements the EU policies regarding the development of the European higher education and the user-friendly information society in particular:

- By improving the quality and diversity of the pan-European HE system
- By promoting the globalisation of the exchange of HE course units
- By enabling partners from economically disadvantaged regions, particularly in Central and Eastern Europe to participate in these developments and helping them to strengthen and enrich their course offerings and the foster the education in general.

Most of the activity within the project will be tightly connected with the usability aspects of the applied methods and technology. Usability evaluation and proposed improvement will be based on the past experiences, guidelines and standards developed within projects that have addressed this issue of modern technology in depth. The consortium expects wide acceptance among the higher-level education institutions in Europe.

References

[1] Advanced Distributed Learning Network (ADLNet), *http://www.adlnet.org*

[2] Instructional Management Systems project, *http://www.imsproject.org*

[3] GESTALT:Getting Educational Systems Talking Across Leading-Edge Technologies, *http:www.fdgroup.co.uk/gestalt/*

[3] SCORM, Sharable Courseware Object Reference Model: *http://www.adlnet.org/Scorm/docs/scorm_2.pdf*

[4] IMS Question & Test Information Model, *http://www.imsproject.org/question/index.html*

[5] SATML Standardised Assessment & Testing Markup Language *http://www.engr.ucf.edu/aim/research/1998/tess/satml/default.htm*

[6] QML Question Markup Language, *http://www.questionmark.com/qml/index.htm*

[7] IEEE LTSC WG17: Content Packaging Working Group, *http://ltsc.ieee.org/wg17/index.html*

[8] IMS Content Packaging Specification, *http://www.imsproject.org/content/index.html*

---

[14] LTDI, Philip Crompton: Evaluation: A practical guide to methods and Stephen Draper: Observing, measuring or evaluating courseware URL:http://www.icbl.hw.ac.uk/ltdi

Which Chinese Input Methods Is More Suitable for Sixth-Grade Pupils? Keyboarding or Non-Keyboarding

Weichung Wang* and Tainshu Ma
Department of Mathematics Education, National Tainan Teachers College
Tainan 700, Taiwan
**E-mail: wwang@ipx.ntntc.edu.tw*

Computers have been wildly used in elementary schools and to input characters is usually necessary while manipulating computers. However, inputting Chinese characters is a burden for Taiwanese pupils. Keyboarding is a traditional method used for inputting Chinese characters. On the other hand, other user-friendlier input tools like speech and handwriting recognition provide alternative choices. We observe three 12-year-old pupils, who have different backgrounds, how they use these different methods to input Chinese characters. Experiments results show that all three pupils make progress after short-time practice for all input methods. Different pupils, however, would choose different input method depending on their own preference and background.

Keywords: **Chinese input method, keyboarding input by pronunciation, speech recognition, handwriting recognition**

1 Introduction

Computers have been widely used in many educational applications like computer-aided learning. For a pupil in Taiwan, one of obstacles that he or she may encounter for using computers is to input Chinese characters.[1] In this study, we intend to explore pupils' behaviors on Chinese characters inputting and then make recommendations in under what conditions what kind of input methods may be used.

Keyboarding and non-keyboarding are two main categories of characters input methods. For keyboarding method, users type Chinese characters either according to their pronunciations or by "dismantling" the characters. For the non-keyboarding methods, handwriting and speech reorganization are two popular methods for inputting Chinese. While keyboarding has been used for longer time and almost always each computer is equipped with a keyboard, non-keyboarding input methods are developed recently and extra equipments and software are needed.

When keyboarding is used, most students input each single Chinese character by spelling its pronunciation.[5] Main reasons are: (1) Students are familiar with the pronunciation. What they have to learn is to memorize the position of each key on the keyboard corresponding to the pronunciations. (2) Psychology indicates that human beings think in the form of tone (of characters), but not the font of the characters.[4] However, disadvantages of this input method exist. (1) Students may not spell pronunciation correctly especially when they encounter new words. (2) Many different Chinese characters have same pronunciations.[3,7] Pupils thus need to choose the target character and the input speed is slowed down. Non-keyboarding input methods, especial the voice reorganization, is one of the hottest research topic in computing. People use natural ways like handwriting or speech to communicate with computers. The computers then analyzed the data to identify what people mean and output the data in a text format.[6]

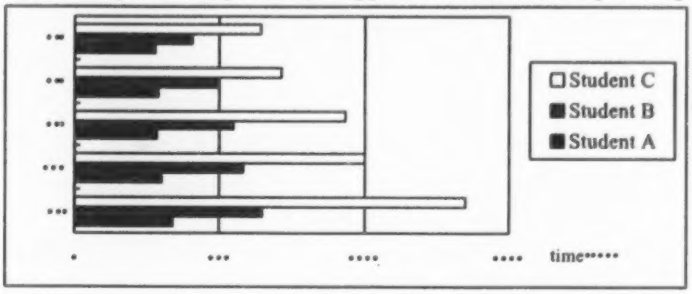
We conduct the study to find out pros and cons of each input methods. Three sixth grade (12-year-old) students with different computing backgrounds are chosen, based on interviewing and simple tests. Student A has a lot of computing experience, student C has little computing experience, and Student B is in between. All three students come from National Tainan Teachers College Affiliated Primary School. For keyboarding input, they use the input method of spelling words' pronunciation that is included in the Windows 98 operation system. For handwriting reorganization, they use "Pen Power Jr." For speech reorganization, they use the product named "IBM ViaVoice." The essay that students input is extracted from the newspaper China Times. There are 142 characters in the essay. To evaluate the performance of different input methods, each pupil has five chances to input the Chinese essay by pronunciation based keyboarding, speech reorganization and handwriting reorganization. Between each of chance, they have a period of 30 minutes to practice. In the next section, we summarize our observations and statistical results toward the problems in each of the sub-sections.

2 Findings and discussion

2.1 Can short-time trainings improve performance of pronunciation based keyboarding?

Figure 1 shows timing in seconds that student A, B, C took to finish the essay in five trials. They are asked to input all characters correctly. All three pupils made progress for the short-time practice. Comparing the first and the fifth performances, we found that student A, B, and C had 19%, 37%, and 53% of progress, respectively. Although student A made less progress, the student actually finished the essay quickest. Beside, students A, B, and C had an average progress of 16, 60, 178 seconds. We noticed that both student B and C kept making progress, but student A had a downgrading performance from the third to the forth trial. The difference between the third and forth trial for student A, however, is not significant. Based on the experimental results, we conclude that short time training does benefit three students in different background. Furthermore, the student with the least computing background actually made the most significant progress.

Figure1. Comparison of input timing using pronunciation based on keyboarding.



2.2 How does the speech recognition input method affect the input efficiency?

Figure 2 shows the percentage of the speech recognition software correctly identify the characters. Both student A and B perform similar from the first to the fifth trial, while student B tends to be better in the first of four trials. Besides, student B makes a great progress from the first trial (77%) to the second trial (92%). Student A and B reached a 100% correct recognition and student C achieved almost 90% correctness. This suggests that, after reasonable training, students with different background can manipulate the speech input method nicely.

Figure 2. The correct recognition percentage of speech recognition.

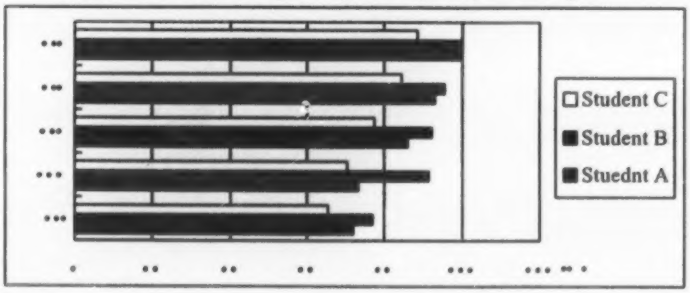
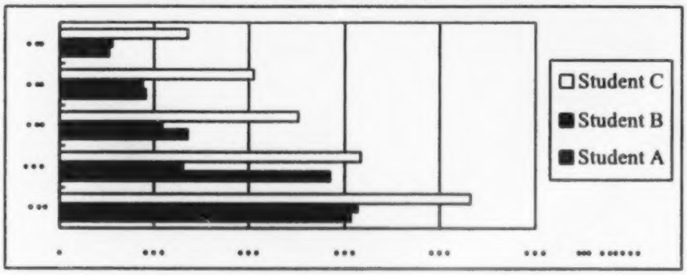


Figure 3 demonstrate timing the pupils took in five trials with emending the wrong characters. When the correct recognition rate is high, the input method can be very efficient, about 160 characters in one minute for student A and B. However, this is not a universal situation. Take student C as the example, the pupil speaks in such an ambiguous tone that the computer simply could not correctly recognize the essay. As the result, the student spent a lot of time to emend the wrong characters and greatly slow down the speed of inputting. Such observations show that there is room for improving the correct recognition rate.

Figure 3. Timing of speech recognition input.



2.3 How does the handwriting recognition input method affect the input efficiency?

Figure 4 reveals the percentage of the handwriting recognition software correctly identify the characters. Both student A and B perform similar from the first to the fifth trial, while student B tends to be better. Besides, student B reached 100% correct recognition at the last two trials, and student C achieved 92% correctness. This suggests that, after reasonable training, students with different background can manipulate the handwriting recognition input method nicely.

Figure 4. The correct recognition percentage of handwritten recognition.

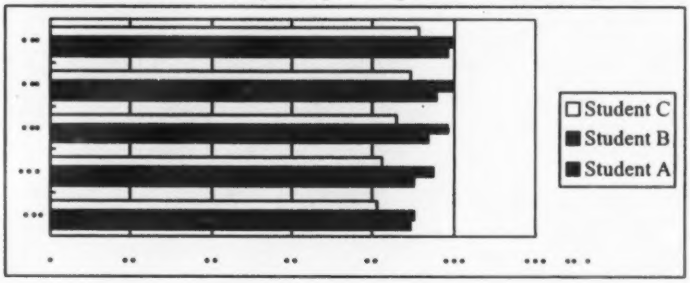
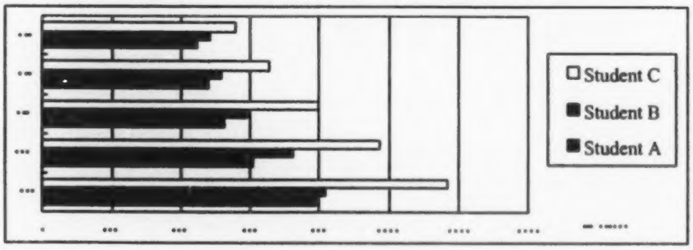


Figure 5 demonstrate timing the pupils took in five trials with emending the wrong characters. We find that both student B and A perform similarly and nicely, though slight differences exist. Main reason why student B outperforms other two students at the correct recognition percentage is the way he wrote Chinese characters. Student B usually writes in a way that the characters strokes are clear and distinct. In contrast, student C tends to write Chinese characters apart and thus make the software consider as several words. Furthermore, student A writes very fast and his written characters strokes are also clear, though a little behind the ones of student B. This characteristic affect the timing of input, while the correct recognition percentage of student A is lower than B, he should took more time in inputting, instead, the timing of input with emending is less than that of student B.

Figure 5. Timing of handwriting recognition input.



2.4 For different students, how the input methods help students to input more efficiently?

For student A, to use keyboarding as input tool is better than the one by non-keyboarding. Because he is familiar with keyboarding and input Chinese even becomes a basic ability as using computer.[2] So that in the test of keyboarding, he exceeded others very much at first, but just for the same reason, he could not make further progress. In inputting by non-keyboarding methods, he did not do such a good job as keyboarding. Take speech for instance, everyone spent almost the same time when they did not need to emend the wrong words, but he spent much more time then student B when emending is needed. Similar result can be found for handwriting method. The recognition rate of student B is better than A.

For student B, to use non-keyboarding as input tool is better than the one by keyboarding. One reason is that he is not as familiar with keyboarding as A does. He usually uses computer to play games or surf the Internet. He actually just needs to use mouse as a tool to communicate with computer. In keyboarding, although his effect is not better than student A, but he has a better progress than student A. If non-keyboarding method is used, no matter speech or handwriting, he did a better job than student A and C. We emphasize that, these three students never use speech or handwritten before, and the result shows that the learning effect of student B is better than the other two students.

For student C, to use keyboarding seems better than non-keyboarding. He made a better progress in keyboarding. In input method of keyboarding, at the last time of test, his input time was even less than that of student B's first trial. This result showed that after short-time training, student C made the greatest progress in keyboarding (53%). For non-keyboarding methods, student C seems had difficulty to adjust his speech tone and handwriting to fit the software. But we think this is the place that software developers should work on. It should be the software developers' responsibility to develop software that is capable of adapting different speech tone and handwriting habit.

3 Conclusions

We have observed the behaviors of using keyboarding and non-keyboarding Chinese input methods. We suggest the following. For students who are familiar with computer and takes inputting as a basic skill, like student A, keyboarding best fits. For those who learn new things very fast, are interested in them, and speak or write well, (like student B) then the non-keyboarding is fit. For a student like the C, who does not learn new things very well and maybe he does not speak or write well, and he is used to input by keyboard, then the keyboarding is fit.

References

[1] Chen, Y.L., "The Input Method of Speech Recognition-Make You Speak Aloud", PC Computing, pp. 3-18, (1999).

[2] Ho, Rong-Guey and Wang, Hsue-Yie and Shyu, Huey-Jiun. "An Adaptive Strategy on Keyboarding: Using Adaptive Drill System Model", http://content.edu.tw/primary/info_edu/tp_tt/content/other/paper2.htm, (1997).

[3] Li, M.C., "The Development of Input Method by Words' Pronunciation", Information and Education, No. 30, pp. 18-22, (1992).

[4] Richard E. Mayer., "Educational Psychology", Taipei: Yuan-Liou, 3rd Edition, (1997).

[5] Suen, D.S., "Let's Use The Special Input Method", Info. Com, No. 218, pp. 91-93, (1998).

[6] Tzeng, U.M., "The Development and Application of Speech Recognition in Computer", Information and Education, No. 52, pp. 10-13, (1996).

[7] Wang, C.F., "The System of Chinese Speech Recognition in Computer", Information and Education, No. 52, pp. 2-8, (1996).

Xtrain: A GUI based tool for Multimedia Presentations, Instruction, and Research

Xiagen Hu* & Scotty D. Craig**
The University of Memphis
University of Memphis, Department of Psychology, Memphis, TN 38152-6400
(901) 678-3608
*E-mail: *xhu@memphis.edu, **scraig@memphis.edu*

Xtrain is a program for scripting and presenting multimedia displays. This program was developed in the Advanced Learning Technologies Laboratory at the University of Memphis and has been used in variety of psychological experiments. This program can combine such multimedia formats as Microsoft agent, Macromedia flash, director and many others that are available for scripting under a GUI Windows environment. Furthermore, Xtrain offers a variety of options for testing styles.

KEYWORDS: **Conversational agents, multimedia applications, Xtrain, Microsoft Agent**

1 Introduction

The idea of embodied conversational agents has generated considerable interest in the realm of HCI recently. Unfortunately, for the most part this has been metaphorical, because computers could not support the needed software. In order for the computer to fully support embodied conversational agents, they would need software that could produce and control many human-like characteristics, such as conversational behaviors, with the ability to mediate the flow of conversation by the use of such things as facial expressions, hand movements and voice intonations [1].

Microsoft made one such attempt at this with their Microsoft Agent program. Microsoft Agent is an interactive interface with conversational capabilities that are embodied in an animated character agent. One example of this is the helper agent in newer versions of Microsoft products such as Microsoft Word and Microsoft PowerPoint. Microsoft Agent is also an optional program for windows 9x operating systems and is available for free download at the Microsoft site. It is compatible with all MS Windows platforms starting with Windows 95. Thus, this agent is readily available for widespread use [5]. The purpose off this paper is not to review Animated Agents for a review, see Johnson, Rickel, and Lester [4].

Furthermore, recent research has shown that the correct use of multimedia presentations can enhance the learning and memory from presented materials. Multimedia in this case refers to any type of pictorial information presented with textual information. However, this form of learning works best with pictorial information shown as an animation that is then coordinated with a narration of any textual information that would be needed [6]. Under the cognitive theory of Multimedia learning, there are three main rules that should be considered for scripting of a multimedia presentation: Spatial contiguity, Temporal contiguity, and Modality. The spatial contiguity effect states that relevant and related concepts should be presented in the same general area of each other (e.g. labeled words should be closer to the object they label than other objects on the screen). The temporal contiguity effect informs us that the various forms of media used during a presentation should correspond with each other by occurring at the same time. Lastly, the modality effect says that if two types of information are presented in the same type of modes, it will hinder learning. However, this can be overcome by presenting information in two modalities. So, printed text and animation on a computer screen would be a hindrance to learning, but a narration and an animation would not [7; 8].

Since Microsoft launched the first version of Microsoft Agent, users and developers have provided a lot of resources for use with the program (e.g., some information can be obtained fromhttp://www.msagentring.org/agentringmain.html). There are several innovated approached both in the use and the scripting of Agents. For example, mash.exe (http://www.bellcraft.com/mash/) provide a very useful scripting tool for agent programming. Many of these programs have been examined, including Mash, and while they have the ability to control Microsoft Agent, they are lacking the ability to synchronize the Agent program with other forms of multimedia.

The Advanced Learning Technologies laboratory at the University of Memphis developed Xtrain as a way to incorporate embodied agents (Microsoft Agent) and other forms of multimedia into instruction, research, and presentations. Psychologists have used products such as Mel©and Super lab©to run experiments, but these programs cannot incorporate newer technology. Xtrain provides ways to script many different kinds of presentations, including Microsoft Agent, audio and video clips, HTML, Macromedia flash files, Macromedia Director files, and many graphics file formats [2, 3].

This software program serves a duel purpose. It is both an authoring tool and presentation tool. These work together to form a powerful and versatile tool for the presentation of various multimedia displays as well as data collection.

2 Authoring tool

The authoring side of the program has two levels (a) overall organization of frames and (b) detailed construction of individual frames. The overall methodology is similar to the SuperLab program used in experimental psychology. The Presentation is organized in terms of a tree structure with each node in the tree as a pointer to presentation frames. Each frame consists of the smallest unit of information and the frames are logically contingent upon each other. Such tree structure serves as basic navigation guidelines. However, the navigation path can be quite flexible depending on the needs of the user. The tree structure can be created using a user friendly GUI. Each frame corresponding to the tree nods can be any of several formats such as text art, pictures with hotspots, video/audio clips, agent interactions, and animations.

Xtrain has extensive options for frame editing. The program has been arranged so that the different editing functions displayed as individual property tabs. Each tab corresponds to a specific multimedia format. A description of the property tabs will follow.

Property Tabs

2.1 Frame Property Tab

The Frame property tab allows the basic outline of the frame to be determined. From here frame duration is set, alone with the frame' s properties, and the frame type. The duration can be anywhere from self-paced to any amount of time desired measured in milliseconds. The type of multimedia desired can be selected under a Frame properties drop-down menu. Under the Frame type dropdown menu, the type of frame can be specified: Normal, Title, Review, Test, or Interaction.

2.2 Agent Property Tab

This is the general tab that is used to control the agent. Each frame can have up to three agent actions assigned to it. These actions are denoted as agent1, agent2, and agent3. However, these can be assigned as needed for example one agent can be given as many as three actions or three agents can be given one action each. These are selected from the available agents using the Agent dropdown menu. Just below this dropdown menu is a dropdown menu that specifies when the agent will be used. For example, "Action over frame" can be selected so the agent is active while the rest of the frame is running. Just below this are three additional tabs that specify (a) the agent's position on the screen, (b) what the agent will say in each frame, and (c) balloon formatting, if the agent has this option. These are the Action and Gesture tab, Speak and Play tab, and Balloon Setup tab, respectively.

Of these tabs, the Speak and Play tab is of the most importance. This frame in its most basic form allows for text to be entered into a text box. The agent reads this text using a text to speech engine. However, this text box can also contain simple markup within the text. This markup includes such speech parameters as volume, emphasis, pitch and speed. These markup tags can be inserted into the text by inputting the desired values into the box beside the parameter name on the right portion of the tab and then double clicking the name. This list of parameters also includes a few special tags that can control the flow of the information delivery. These tags permit the agent to skip to a specific frame in the tree structure (Show Frame), or to go to specific frames in a selected Shockwave Flash movie (Go to Frame in Flash Movie). The remaining tag option is Insert Special action. This set of tags allows the user to start, stop, and restart a flash movie, and provides a tag that terminates the program at the end of a presentation. The Speak and Play tab allows for assignment of actions to the selected agent. These actions vary according to the abilities of the selected agent, and can be assigned either at the beginning or the end of the text the agent speaks.

Similar to other agent scripting tool, such as MASH, this agent property editor uses all available Microsoft agents controls. In addition, Xtrain utilizes the bookmark function of MS Agent to control the overall flow of the presentation. In fact it is the use of these bookmarking functions that make it possible to control Multimedia synchronization, such as with Flash animation, which is lacking in the other agent programs.

2.3 Text Display Tab

The text display tab is used to insert text to be displayed on the screen. Doing this involves clicking on the display area, typing in the text to be displayed, and then clicking update. The text will then appear in the display area in the same way that it will be displayed on the screen during the presentation.

2.4 Multimedia Tab

The Multimedia tab allows you to assign audio files, movie files, and wallpaper to the frame. The program supports wave files (.wav) and Enhanced Linguistic files audio formats. If an Enhanced Linguistic file is used Microsoft Agent can be made to appear to speak the file. The movie files available from this tab are AVI (.avi) and Mpeg (.mpg). A Bitmap (.bmp) image can be set as a background that either covers the whole screen or centered.

2.5 Pictures Tab

Using the picture tab, a picture can be added to the frame and manipulated. Xtrain supports two types of graphic files: Bitmap (.bmp) and GIF (.gif). The picture can be located at any point on the screen, centered, or can move from point to point. A hotspot option can be added to the picture to be used to give commands to the agent or to play audio files. Each hotspot can have information, such as text and tagged markup, to be sent to any selected agent.

2.6 Shockwave Tab

Under this tab, there are two options: Flash Movie and Shock Wave Movie. Flash movies and shockwave animations are among the most frequently used multimedia format. Xtrain uses activeX control from macromedia so both types of movies can be manipulated. By loading flash movie from this tab, detailed frame information can be examined so Agents can navigate through the movie. In addition, Xtrain uses FSCommand of flash movie to control Agent and the tree navigation.

2.7 Frame Summary Tab

The frame summary tab gives summary information both at the scripting phase and at the presentation phase. At the scripting phase, it gives a brief overview of the selections made in the other tabs for that frame. If the frame is a test frame, it also contains the correct answers to the questions given in the test frame. After viewing on the other half of this frame, responses are shown. If it was a test frame, the student' s responses are listed along with whether the response was correct.

2.8 HTML Tab

The program allows for the incorporation of html documents into presentations. This allows greater flexibility in terms of specialized displays. The format allows for html documents that are locally saved in the Xtrain directory to be displayed and navigated during presentations.

2.9 Test Tab

One other important feature of Xtrain is the testing option. During the scripting phase, frames can be assigned as testing frames on the frame property tab. These frames can be used to capture information from the user. They allow input in such forms as multiple-choice questions, short answer questions, and even essays. At the end of the presentation phase, input from the participant is automatically saved as an ASCII text file. The agent can also be programmed to give dynamic feedback, when the participant gives wrong answers.

3 Presentation Tool

The presentation of the scripted material is as easy as selecting the run drop-down menu and selecting the run entire session option. Alternatively, the Xtrain presentation file (.xtr) can be ran by double clicking its icon in the strain folder. This action occludes all other objects on the screen: only the scripted presentation and a control bar are visible. This control bar is a flash file that allows for the following actions: go back, continue, help, and progress. The presentation continues forward until it reaches the end of the presentation.

4 Summary

Xtrain is a program that is able to integrate multimedia files into one presentation format. The authoring side of the program takes advantage of many Windows' standards for ease of use. It provides a standard Windows interface window with icon buttons and drop-down menus, such as File, Edit, Window, and Help. These offer such options as open and save in the File menu, as well as, cut, copy, and paste in the Edit menu. Xtrain also offers a special drop down menu labeled Run. This menu offers the options of running the entire session or of previewing a selected frame. See Figure 1 for a view of the program. The frames are structured in a tree format that is located on the left of the screen. This tree is created via buttons labeled Brother, for frames on the same level, and Child, for frames on a branching level. Each frame can be scripted using nine different property tabs: Frame Property, Agent Property, Text Display, Multimedia, Picture, Shockwave, Frame Summary, HTML, and Test. These tabs may be individually associated with each frame. It is from these components that the script is produced to set the required tone for the information to be presented. Microsoft agent can also be used to control the flow between frames, so that if the need arises the agent can direct the presentation to any frame in the tree. Furthermore, if a Shockwave Flash file is used, the agent also has the ability to direct the flash movie to any frame within the movie. These options allow for maximum flexibility for the user when scripting a multimedia presentation. In addition to this freedom in scripting, Xtrain offers an easy presentation method that either selecting run entire session from the run menu or by simply double clicking on the created Xtrain file.

References

[1] Cassell, J., Bickmore, T., Billinghurst, M., Campbell, L., Chang, H., Vilhjalmsson, H., Yan, H., "Embodiment in Conversational Interfaces: Rea." Proceedings CHI' 99. Pittsburgh: ACM. (1999).

[2] Craig, S. D., & Hu, X. Xtrain: Expert training and data collection system. Presented at the 1999 meeting of The Society for Computers in Psychology. Los Angeles, California. (1999, November).

[3] Hu, X. "Xtrain 1.0 [computer program]." The University of Memphis: Author. (1998).

[4] Johnson, W. L., Rickel, J. W. & Lester, L. Animated pedagogical agents: Face-to-face interaction in interactive learning environments. International Journal of Artificial Intelligence in Education, Vol. 11, in press, (2000).

[5] Microsoft. Microsoft Agent 2.0 [computer program]. (1998).

[6] Mayer, R. E. Multimedia learning: Are we asking the right questions? Educational Psychologist, 32, 1-19, (1997).

[7] Mayer, R. Using Illustrations to Promote Constructivist Learning from Science Text. Psychology of Science Text Comprehension. (Submitted).

[8] Moreno, R., & Mayer, R. E. Cognitive principles of multimedia learning: The role of modality and contiguity. Journal of Educational Psychology, 91, 358-368, (1999).